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CONFEDERATE ORDNANCE DURING THE WAR.

Wm. Le Roy Brown, President Alabama Polytechnic Institute, Auburn. Formerly Lieutenant-Colonel of Ordnance of the Confederate Army, Commanding the Richmond Arsenal.

In complying with your request to write an article for your *Journal* giving experiences and difficulties in obtaining ordnance during the war, I will endeavor relying on my memory and some available memoranda preserved, to give you a statement of the collection and manufacture of ordnance stores for the use of the confederate armies, so far as such manufacture was under my observation and control. After a year's service in the field as an artillery officer, I was ordered to Richmond and made Superintendent of Armories, with the rank of Major in the regular army, a new office in the C. S. army, and sent to various points in North Carolina and Georgia, to inspect and report on the facilities possessed by different manufactories for making arms, swords, sulphuric acid, etc.

As a general rule the facilities for manufacturing were meagre and crude, giving little prospect for an early serviceable product.

Early in the spring of 1862 I was ordered to report at Holly Springs, Mississippi, and take charge of a factory just purchased by the Confederacy, and designed for the manufacture of small arms. It was not many months before the defeat of the Confederate army under General Albert Sydney Johnston, at Shiloh, Tenn., caused a hurried removal of all the machinery to Meridian, Miss. Having reported to the chief of ordnance at Richmond, Va., I was assigned to duty connected with the ordnance department.

The Confederate Congress had authorized the appointment of fifty new ordnance officers, and the applications to the war department became so numerous and persistent for these appointments,

that the Secretary of War, Colonel Randolph, ordered that all applicants should submit to an examination, and that appointments would be made in order of merit, as reported by the board of examiners. Thus what we are now familiar with as Civil Service examinations, were introduced by the Confederate War Department in 1862, in the appointment of ordnance officers.

I was made Lieutenant-Colonel of Ordnance, and as President of the Board, with two other officers, constituted the board of examiners. By direction of General J. Gorgas, the Chief of Ordnance, I prepared a Field Ordnance Manual by abridging the old United States Manual and adapting it to our service when necessary. This was published and distributed in the army.

The examination embraced the field ordnance manual as contained in this abridged edition, the elements of algebra, chemistry, and physics, with some knowledge of trigonometry. The first examinations were held in Richmond. Of course the fact of the examinations greatly diminished the number of applicants. Of those recommended by the board, so many were from Virginia that the President declined to appoint them until an equal opportunity was given to the young men of the different armies of the Confederacy in other states.

Hence I was directed to report to and conduct examinations in the armies of Generals Lee and Jackson in Virginia, General Bragg in Tennessee, and General Pemberton in Mississippi. Under other officers examinations were conducted in Alabama and Florida.

The result of this sifting process was that the army was supplied with capable and efficient ordnance officers.

Early in 1863 I was appointed Commandant of the Richmond Arsenal. Here the greater part of the ordnance and ordnance stores were prepared for the use of the Confederate armies.

The Arsenal occupied a number of large tobacco factories at the foot of Seventh street near the Tredegar iron works between Cary street and James river. It included all the machine shops for working wood and iron organized into different departments, each under subordinate officers, arranged to manufacture ordnance stores for the use of the Confederate army.

Cannon were made at the Tredegar iron works, including siege and field guns, Napoleons, howitzers, and banded cast-iron guns. Steel guns were not made. We had no facilities for making steel, and no time to experiment.

The steel guns used by the Confederates were highly valued,

and with the exception of a few purchased abroad were all captured from the Federals.

At the beginning of the war the machinery belonging to the armory at Harpers Ferry was removed to Richmond, and there established. This armory manufactured Enfield rifles, and the product was very small, not exceeding five hundred per month.

With the exception of a few thousand rifles, the soldiers at the beginning of the war were armed with the old smooth-bore muskets, and with old Austrian and Belgian rifles imported. These they exchanged for Enfield rifles as they were favored by the fortunes of war.

In the summer of 1862, after the seven days battles around Richmond between General Lee and General McClellan, men were detailed to collect arms from the field, which were carried to the Richmond Arsenal. And then as quickly as possible repaired and reissued to the army. Subsequently through the blockade runners a large importation of excellent rifles was received and distributed.

When the men detailed for this purpose were collecting the thousands of Enfield rifles left by the Federals on the battle fields around Richmond, I remember seeing a few steel breast plates that had been worn by the Federal soldiers who were killed in battle. They were solid steel in two parts, shaped to fit the chest, and were worn under the coat. These were brought as curiosities to the Arsenal, and had been pierced by bullets. I remember this as a fact of my own knowledge. Some years ago the charge that some of the Federal soldiers wore breast-plates was denied and decried as a gross slander, and in reply thereto I published in the *Nation* the statement here made. These no doubt represented a few sporadic cases, worn without the knowledge of others. The Confederate soldiers had to rely for improved arms on captures on the battlefield, and on importation, when the blockade could be avoided, having available no large armory.

The Tredegar iron works at Richmond, Virginia, was the chief manufactory of seige and field guns, all cast iron and smooth bore. The large Columbiads were made there, also the howitzers, 12-inch bronze Napoleons, etc. But the highly valued banded Parrot 3-inch rifles, with which the army was well supplied, were, as a rule, captured on the battlefield.

As the war continued great difficulties were experienced in obtaining the needful ordnance supplies, and many devices were resorted to. After the battles about Chattanooga, Tennessee,

when the Confederacy lost possession of the copper mines, no more bronze Napoleons could be made; but instead thereof, a light cast-iron 12-pounder, well banded after the manner of the Parrot guns, was made, and found to be equally as effective as the Napoleon.

At the beginning of the war it must be remembered the Confederacy had no improved arms, no powder mills, no arsenals, no armories, no cap machines, and no improved cannon. All supplies, at first, were obtained by importation, though the blockade subsequently cut off this foreign supply. All arms were percussion-cap muzzle loaders. In the beginning the old flint-lock smooth-bore muskets were changed to percussion-cap lock, and issued to the troops.

To keep a supply of percussion caps was a difficult and very serious problem, as the demand for caps was about twice as great as it was for cartridges.

The machines made after the United States pattern did not yield a large supply, and simpler and much more efficient machines for making fitting, pressing, and varnishing caps were invented and made by southern mechanics.

After the Federals obtained possession of the copper mines of Tennessee great anxiety was excited as to the future store of copper, from which to manufacture percussion caps.

The casting of bronze field guns was immediately suspended and all available copper was carefully hoarded for the manufacture of caps. It soon became apparent that the supply would be exhausted and the armies rendered useless unless other sources of supply could be obtained. No reliance could be placed on the supply from abroad, though large orders were forwarded, so stringent was the blockade; of course the knowledge of this scarcity of copper was not made public.

In this emergency, it was concluded to render available if possible, some of the copper turpentine and apple-brandy stills which still existed in North Carolina in large numbers.

Secretly, with the approval of the Chief of Ordnance, an officer was dispatched, with the necessary authority to purchase or impress all copper stills found available, and ship the same, cut into strips, to the Richmond Arsenal. By extraordinary energy he was enabled to forward the amount necessary for our use. The strips of copper of these old stills were rerolled and handed over to the cap manufacturer. And thus were all the caps issued from the arsenal and used by the armies of the Confederate

states, during the last twelve months of the war, manufactured from the copper stills of North Carolina.

After the completion of the cap machines, which were an improvement on the old United States machine, eight hands only, two being men, the others boys and girls, frequently manufactured from the strip copper over three hundred thousand caps, within eight hours, stamping, filling, preparing and varnishing them.

These cap machines thus had a capacity of producing a million a day.

These caps made at the arsenal were frequently tested, and pronounced to be superior in resisting effects of moisture and in general efficiency.

For the completion of these machines, the Confederate government awarded the inventor, an employée of the arsenal, the sum of one hundred and twenty-five thousand dollars, being then equal to two thousand in gold.

To manufacture the fulminate of mercury we needed nitric acid and mercury.

A quantity of mercury was obtained early in the war from Mexico. To make nitric acid we required nitre and sulphuric acid. The sulphuric acid we manufactured in North Carolina, after many failures and difficulties, especially in obtaining the lead to line the chambers.

Nitre was made by the Nitre and Mining Bureau, especially organized for that purpose. Everywhere about the environs of Richmond could be seen large earthen ricks and heaps which contained dead horses and other animals, designed for use in the manufacture of nitre. The available earth from caves was also made to yield its quota of nitre. With this sulphuric acid and nitre, on the banks of the James river, we manufactured the nitric acid required in the manufacture of fulminate.

Near the close of the war the supply of mercury became exhausted. Here was a most serious difficulty, we had not and could not obtain the mercury, an essential material with which to manufacture fulminate of mercury; and without caps the army could not fight, and must be disbanded. This was an extremely serious situation, as no mercury could be obtained in the limits of the Confederacy. We began to experiment on substitutes, and fortunately found in Richmond two substances, chlorate of potash and sulphuret of antimony, which, when properly combined answered the purpose satisfactorily. And the battles around Petersburg during the last few months of the war were

fought with caps filled with this novel substitute. Our lead was obtained chiefly, and in the last years of the war, entirely from the lead mined near Wytheville, Virginia.

The mines were worked night and day, and the lead converted into bullets as fast as received.

The old regulation shrapnel shells were filled with leaden balls and sulphur. The Confederacy had neither lead nor sulphur to spare, and used instead small iron balls, and filled with asphalt.

We had no private manufactories established which could furnish the appliances needed, and frequently everything had to be done from the very beginning, by the ordnance department, and the army in the field. For instance, to run the forges to make the irons for the artillery carriages we needed charcoal. To obtain this I purchased the timber of a number of acres of woodland on the south side of the James river, and secured a detail of men to burn the charcoal for the use of our forge department.

During the winter men from General Lee's army cut the timber and shipped it to Richmond, with which artillery carriages were made on which to mount the guns to fight the battles in the spring. Men appointed for that purpose followed the army and collected the hides of the slaughtered animals that were used to cover the saddle-trees made of timber, cut by temporary details of men from the army in the field.

As the war continued efforts were made to build permanent and well appointed arsenals, as at Macon and Augusta, Georgia.

The large arsenal at Augusta, under the management of Colonel Rains was especially devoted to the manufacture of powder. Toward the close of the war it was making an abundant supply of very superior character, equal, and in some respects, superior to that imported from foreign countries.

Under the demands of necessity in many instances, cotton converted into rubber cloth was used in the manufacture of infantry accoutrements, and was found especially useful in making belts for machinery. Models of inventions were frequently sent to the arsenal, of which large numbers were valueless, and those good in theory could not be tried for want of skilled machinists and ordnance supplies. I remember on one occasion, the last year of the war, that a large number of Spencer breech-loading rifles, the result of a capture, were turned over to the arsenal, and though greatly desired by the troops, could not be reissued for want of ammunition. In the effort to make the cartridges for the Spencer rifles, in the first place tools had to

be devised, with which to make the tools used for making the cartridges. Hence the surrender of Richmond came before the cartridges were made.

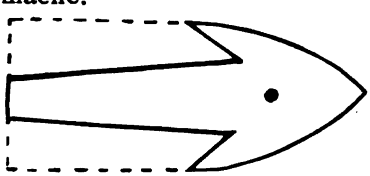
A plan was proposed at the arsenal to increase the accuracy and range and thus render available and more efficient the smooth-bore muskets in possession of the Confederacy.

The plan proposed was theoretically correct and is worth mentioning, inasmuch as very late in the war the identical plan was sent to President Davis from Canada, as a scientific gift of great value.

This was sent by him to the war department, and hence found its way to the arsenal, where the drawings were regarded with interest since they corresponded exactly with those made at the arsenal years previously.

The idea was to fire an elongated compound projectile made of lead and hard wood, or papier maché.

In the diagram the heavy lines represent a section of the leaden arrow bullet, with center of gravity well forward, the dotted lines represent the hollow sabot of wood, or hard papier maché.



On firing, the lighter material, moving first, would press outwards the arrow head, and thus destroy windage, and the flight of the trajectory would be as an arrow, without rotating on the shorter axis, inasmuch as the center of inertia of the projectile would be in advance of the center of resistance of the air. At least that was the theory of the compound projectile, devised for the old smooth-bore musket.

An attempt was made to use on the field round concussion shell from the howitzers as mortars. In this concussion shell a friction primer properly wrapped acted as a fuse, its head terminated in a bullet which rested on the shoulder of the brass fuse that screwed into the shell, leaving an unfilled hollow space about the bullet. When the round shell struck any point, except that exactly in rear of the prolongation of the wire, put in the axis of the bore by using a sabot, the momentum of the bullet would draw the friction primer and explode the shell, regardless of the point on which a round shell struck. A gun carriage was made for howitzers with a jointed trail, as thus they could be used as mortars, and fired at a high angle.

These were rather experiments than instances of success, and are only mentioned now to show that the ordnance officers did

something more than simply attempt to imitate the Federals.

They were prevented from accomplishing what they planned by reason of the want of machinery to do the necessary work.

During the siege around Petersburg it was discovered that the shells used for the large Parrot guns were very defective, that is, had but very short range. The shells would start off and fly well, and straight, revolving on the longer axis during the first half of the trajectory, and then suddenly whirl on the shorter axis and drop almost vertically. One can tell by the ear the instant the axis of revolution changes, if one gun is fired. The action of the shell being observed, the cause was obvious and a remedy suggested itself. The center of the resistance of the air at the summit of the trajectory, was in advance of the center of inertia, and produced a couple that caused the rotation on the shorter axis. The obvious remedy was to make the front of the shell hemispherical instead of conoidal, and diminish its length, and thus put the center of gravity forward of the center of resistance. With this change made, the maximum range was attained ; and the complaints of the artillerist ceased.

When we consider the absence of manufactories and machinery and of skilled mechanics in the South at the beginning of the war, its successfully furnishing ordnance supplies for so large an army during the four eventful years, is a striking evidence of the energy and resources and ability of its people.

The success of the ordnance department was due to its able chief, General J. Gorgas, and in large measure, to the intelligence and devotion of its officers selected by the sifting process of special examinations.

I must add this, that never was an order received from General Lee's army for ammunition, that it was not immediately supplied, even to the last order to send a train load of ammunition to Petersburg, after the order was received for the evacuation of Richmond.

As continuous work was necessary to keep a supply of ammunition at times serious difficulties threatened the arsenal, not only from scarcity of supplies of material, but also from depreciation of our currency.

Food supplies were very scarce in Richmond and became enormously high in Confederate currency, and during the very severe last winter of the war all the female operatives who filled cartridges with powder, left the arsenal and struck for higher wages. These were trained operatives, and the demand for ammunition

was too great to afford time to train others even if they could have been secured.

An increase in money wages would not relieve the difficulty.

I remember once being, early in the morning, on the island in James river, with the ice and frost everywhere, surrounded by a number of thinly clad, shivering women, and mounting a flour barrel, I attempted to persuade them by appeals to their loyalty and patriotism to continue at their work until better arrangements could be made.

But patriotic appeals had no effect on shivering, starving women. Very fortunately at this juncture a vessel with a cargo for the ordnance department, ran the blockade at Wilmington, North Carolina, laden, not with rifles and powder, but with bacon and syrup, and articles for food and clothing, these being of extreme value. An ordnance store was immediately established, and food and clothing sold to the employées of the arsenal at one-fourth the market price. This fortunate cargo made all happy, and relieved the impending difficulty.

I submit herewith, a statement of the principal issues from the arsenal made up to January 1st, 1865.

This can be relied on as accurate, having been copied from the official reports preserved at the arsenal, consolidating all issues.

The report was prepared by my order, furnished the *Richmond Enquirer*, and published the day of the evacuation of Richmond.

A copy was published in the *New Eclectic Magazine*, April, 1869, from which this extract is taken.

STATEMENT OF PRINCIPAL ISSUES FROM THE ARSENAL.

Statement of principal issues from the Richmond Arsenal, from July 1st, 1861, to January 1st, 1865.

Artillery Equipments, Etc.

341 Columbiads and seige guns.
1,306 field pieces of all descriptions.
1,375 field gun carriages.
875 caissons.
152 forges.
6,852 sets artillery harness.
921,441 rounds field, seige, and sea-coast ammunition.
1,456,190 friction primers.
1,110,966 fuses.
17,423 port-fires.
3,985 rockets.

Imfantry and Cavalry Arms, Accoutrements, Etc.

323,231 infantry arms.
34,067 cavalry arms.
6,074 pistols.
44,877 swords and sabres.
375,510 sets of infantry and cavalry accoutrements.
188,181 knapsacks.
478,498 haversacks.
328,977 canteens and straps.
115,087 gun and carbine slings.
72,413,854 small arm cartridges.
146,901,250 percussion caps.
69,418 cavalry saddles.
85,139 cavalry bridles.
75,611 cavalry halters.
35,464 saddle blankets.
59,624 pairs spurs.
42,285 horse brushes.
56,903 curry combs.

The enormous amount of "thirteen hundred field pieces of all descriptions" classed among the issues, does not signify that that number was manufactured at the arsenal, but that number includes all those obtained by manufacture, by purchase, or by capture, and afterwards issued therefrom. The writer in the *Enquirer* further says, "assuming that the issues from the Richmond arsenal have been half of all the issues to the Confederate armies, which may be approximately true, and that 100,000 of the enemy were killed, not regarding the wounded and those who died of disease, it will appear from the statement of issues, that about 150 pounds of lead and 350 pounds of iron were fired for every man killed, and if the proportion of killed and wounded be as one to six, it would further appear that one man was disabled for every 200 rounds expended. In former wars with the old smooth-bore musket it was generally said, 'his weight in lead is required for every man who was killed.'"

And from the issues of the arsenal it does not appear that the improved rifle requires a pound less.

It will appear to one fond of statistics, who may reduce the moving force of the projectiles to horsepower, that the force required to kill one man in battle will be represented by about one thousand horsepower.

Some general remarks in reference to the conclusion of the war and the destruction of the arsenal may not be out of place.

There was a large number of Federal prisoners in and about the city, Libby prison was filled with officers, and Belle Isle with many privates.

To release these was the object of cavalry raids against the city, when the main army was absent.

All the operators of the arsenal, and the Tredegar works, and employees of the departments were organized in regiments, and were called to the field when a raid was expected.

So they literally worked with their muskets at their sides,—and so valuable were the lives of the skilled artisans that it was said, if three iron workers in the regiment of the arsenal were killed the manufacture of cannon would stop.

But the end was approaching. In the Confederate Senate I remember listening to an animated discussion in regard to enlisting negro troops in the army.

It was urged by some of the senators that we should enlist and arm fifty thousand negroes, of course with a pledge of freedom.

I knew we could not possibly arm five thousand. The Ordnance Department was exhausted. One company of negroes was formed, and I witnessed the drill in the Capitol Square, but I understood as soon as they got their uniforms, they vanished in one night.

As the spring of 1865 approached the officers often discussed the situation. We knew that Lee's lines were stretched to breaking, we knew the exhausted condition of every department, and we knew the end was near.

Sunday, April the second, was a bright, beautiful, spring day, and Richmond was assembled at church. I was at St. Paul's church, about four pews in front of me sat President Davis, and in a pew behind him General Gorgas, Chief of the Ordnance Department and my chief. During service and before the sermon the sexton of the church, a well-known individual in the city, stepped lightly forward, and touching Mr. Davis on the shoulder, whispered something to him.

Mr. Davis immediately arose and walked out of the church with a calm expression, yet causing some little excitement. In a moment the sexton came back and called out General Gorgas. I confess I was made extremely uneasy, and was reflecting on the probable cause, when being touched on the shoulder, and looking around, the sexton whispered to me that a messenger from the War Department awaited me at the door.

I instantly felt the end had come.

I was ordered to report to the War Department, where I soon

learned General Lee had telegraphed that his line was broken and could not be repaired, and that the city must be evacuated at 12 o'clock that night.

I was ordered to remove the stores of the arsenal, as far as could be done, to Lynchburg, and was informed that the President and chief officials would proceed to Danville, and the line be re-established between Danville and Lynchburg.

I immediately had the canal boats of the city taken possession of, and began to load them as rapidly as possible with machinery, tools, stores, etc., to be carried to Lynchburg.

As a large supply of prepared ammunition could not be taken, I had a large force employed in destroying it by throwing it in the river.

Supplies of value to families were given away to those who applied. By midnight the boats laden with stores were placed under charge of officers and started for their destination, which they never reached. What became of them I never knew.

About two o'clock in the morning General Gorgas, the Chief of Ordnance, came to the arsenal to tell me that he was about to leave with the President for Danville, and to report to him there. I never reported to him till fifteen years later, when I met him at Sewanee, Tenn., the Vice-Chancellor of the University of the South.

Every possible effort was made to prevent the destruction of the arsenal.

I, as commanding officer, visited every building between three and four o'clock in the morning of the 3rd of April, had the gas extinguished, and the guards instructed to shoot any man who attempted to fire the buildings.

One hour afterwards (I was then four miles from the city) the rapid and terrible explosion of the shells heard in the distance, proved that that part of the city occupied by the arsenal was being made desolate by the torch applied by the frantic mob. Shortly after the President left the city the gunboats were blown up.

After witnessing the explosion from the steps of the arsenal, I sent for the keeper of the magazine and satisfying myself that life would not be endangered by its destruction, wrote an order for him to explode the magazine at five in the morning, the last order of the Ordnance Department, and among the last orders of the Confederate Government, given in the city of Richmond.

As I rode out of the city in the early dawn, I saw a dense cloud of smoke suddenly ascend with a deafening report that shook the city to its center.

Thus ended the surrender of the city of Richmond.

The mob immediately took possession, looted the stores, and fired the city.

A large part of beautiful Richmond was burned to the ground.

The Federal troops marched into the burning city in splendid order, took possession, dispersed the mob and saved, by their energy and discipline, the city from total destruction.

HOWITZERS AND MORTARS FOR FIELD ARTILLERY, TO SUPPLY A NEED OF CURVED FIRE.

By Tiedemann, Major and *Abteilungs-Kommandeur* in the Posen Field Artillery Regiment, No. 20.
Jahrbücher für die deutsche Armee und Marine, October, 1897.

A. Is the Introduction of such pieces necessary?

I. LESSONS FROM THE HISTORY OF WAR.

In the combats and battles of the latter half of the present century, there is observable a growing tendency to make the most of the power of the fire-arms by occupying defensive positions strengthened artificially, either hastily or with care.

As instances of such defensive positions might be named: *Sebastopol*, which at the opening of the war of 1854 was still very imperfectly protected by earth-works; also the fortifications of *Vercelli*, *Palestro* and the bridge-head of *Turbigo* on the part of the French in 1859; and *Somma-Campagna* and *Chlum* on the part of the Austrains in 1866; and finally the field fortifications in the American War of Secession, 1861-1865.

Especially is the last named notable for the use made of field fortifications both on the offensive and the defensive. To protect themselves from the enemy's fire earthen parapets four to six feet high were thrown up, the earth being taken from both sides; a log was secured along the interior crest, and timber or heavy plank placed against it sloping to the rear, and good shelter thus obtained. The men soon perceived the value to themselves of the parapet and its shelter, and as a rule set about the construction without compulsion, often completing it in a night. A frontal attack following an insufficient artillery fire would invariably be repulsed, with losses that often amounted to fifty per cent of the troops engaged in the assault.

At *Atlanta*, *Richmond*, *Petersburg*, *Bunker Hill*, and *New Orleans*, such field fortifications were of great value, permitting considerably inferior forces to make a successful defence against superior numbers.

The French in 1870 instructed by this American experience made free use of intrenchments. The great losses the Germans suffered on their right wing and center on August 18, 1870, point

clearly to the value of the fortifications the French had constructed here, though these fortifications in themselves were weak. The French long held their ground here, and suffered comparatively little loss, while on their right the 6th Corps, but little aided by field fortifications, gave way at the first German onset.

The influence of an artificially strengthened defensive position has no more conspicuous example than *Plevna* in 1877 in the Turko-Russian war. The field fortifications that the Turks constructed here held the Russians fast for 4⅔ months, though the reinforcements that came to the Russians as the siege went on made their numbers considerably more than the Turks. The latter were able nevertheless in the course of the siege to improve and strengthen their defenses. After the first unsuccessful assaults, the Russians when exposed to the Turkish fire had recourse to the very means the Americans had adopted on the offensive, twelve years before. As attackers, they intrenched themselves in the face of the enemy.

After the taking of the *Shipka-Pass,* the Russians found themselves forced to adopt the role of the defensive, and constructed field fortifications to strengthen their resistance. These proved of great utility, for here as with the Russians before Plevna, the Turks attempting to storm the works with superior numbers were broken up and repulsed at the line of defense of their enemy.

II. THE EFFECT OF LONG CANNON AGAINST FIELD FORTIFICATIONS.

Cannon with long bores are designed to fire at vertical targets, and the trajectory of their projectiles is as nearly horizontal as possible. From their nature therefore they are of little value against targets which are protected against an angle of fall of 20° or thereabouts. An angle of fall as great as this is first reached at 4000 m. (4375 yards) and at this range the probability of hitting is much less than at smaller ranges. Since the penetration of the shell of field guns is moreover slight, it is evident that little can be accomplished against field fortifications by this kind of fire, which up to about the year 1872 was the only kind in use.

Snrapnel then coming into general use, the possibility of hitting hidden targets increased, for to the angle of fall of the complete projectile must now be added one-half of the angle of the cone of dispersion of the shrapnel. But this seeming advantage was met by making the parapet somewhat higher, or the trench deeper. Besides this increased protection against artillery fire,

overhead shelter was also secured after the manner of the Americans in the war of secession, and these proved a complete protection against shrapnel fire.

Just as before, the field gun was effective against rifle pits constructed for men kneeling or lying down. But when the trench is deepened and more earth thrown on the parapet, such a cover is obtained that a man sitting with his back against the steep interior slope is entirely protected against the field gun firing shell and shrapnel.

Only in the artillery of those states that still have shell for their field guns would an attempt be made to destroy the parapet by crumbling down the crest or firing through it. Experimental trials in this line show that after the expenditure of much ammunition parapets from 2 to 3 m. (6½-10 ft.) thick will occasionally exhibit a furrow as wide as 2 m. (6½ ft.) at the top, and sometimes 1 m. deep; the thinner parapets are sometimes perforated by several projectiles striking at the same place, but for the most part the interior slope remains intact. Hence it follows that the defender sitting behind his parapet is almost completely protected against shell, and likewise against shrapnel at 4000 m. (4375 yards), if he is secure against an angle of incidence of 30°, for the angle of fall is about 20° and half the angle of the cone is 10°. At closer ranges than 4000 m. the probability of being hit is still less, for as the range decreases so also does the angle of fall.

The tactical precepts of nearly all the great European states teach that the artillery duel shall precede the infantry attack, and that the artillery after overpowering the enemy's guns shall direct its fire against his infantry. From what precedes we see that the defenders of intrenchments, which give cover against an angle of incidence of 30°, will suffer no loss, nor be shaken in their power of resistance, if they sit up against the interior slope.

The line of conduct of infantry stationed in intrenchments giving such protection is readily inferred. Sitting protected against the enemy's fire, they quietly await the issue of the artillery duel. If this turns out unfavorably to the defense, they remain sitting under cover until the assaulting troops have arrived at a distance of 300 to 400 m. (330-440 yards), the advance of these troops having been hindered as much as possible by that portion of the infantry of the defense not protected against an angle of fall of 30°.

It is understood here that field intrenchments like those of Plevna will seldom be met with, for such require as a rule more

than 12 hours work in their construction, and even when built can very frequently be turned. It *is* assumed however that adequate shelter trenches* for infantry and embrasures for artillery have been constructed at those points of the line of defense where the decisive struggle is apt to occur, or which are weakest either naturally or because they are thinly manned.

When the assaulting troops have arrived at a distance of 300 to 400 m. (330-440 yards) from the infantry of the defense that has hitherto been under cover, the latter step on the banquette and receive the enemy with a destructive fire at close range from magazine small arms. The shrapnel fire of the artillery of the attack cannot now be directed againt these unshaken troops of the defense, for the variation in the point of bursting of the shrapnel would make this fire dangerous for their own troops.

It is necessary further that from the *beginning* of the infantry attack the artillery of the offensive keep up an active cannonade against the troops in the shelter trenches to prevent their delivering an annihilating fire against the assaulting troops, who would be entirely exposed, while the defenders presented but the head.

To this last statement, it may be objected that shelter trenches skilfully constructed cannot be seen by the attackers at a distance of two or three kilometers (1¼ to 2 miles). It is to be observed, however, that the units of the defense in battle, whether infantry or artillery, are more or less confined to a single station, and so form an unbroken chain of infantry and batteries, without any large gaps. Where the ground is such that it will not permit of tiers of infantry fire in several lines one behind the other, the attacker will recognize the position of shelter trenches by the breaks in the chain of the defense. These breaks will be evidence of the presence of shelter trenches.

This leads up to the question where these trenches will be placed along the line of the defense. They should never be pushed forward of the front line; rather *in* the front line or behind it. When in the front line, they would appear to the attackers as gaps, provided the defense up to the critical moment of the assault concealed the fact that they were manned; if the trenches were behind the front line, they would be recognised by

* *Shelter trench* is used here and afterwards as the equivalent of *Deckungsgraben* in the original, which the author limits to such intrenchments as give protection against field guns firing shrapnel.—Trans.

the fact that the supports going to the front as skirmishers would not pass over the ground across which the works lay. The existence of such works could also be discovered by a cavalry reconnaissance or by an observer in a captive balloon.

The defenses can also be so prepared that when the artillery duel becomes hopeless, the defense can rapidly withdraw its guns out of reach of the enemy's fire, when the commander so orders. Of course before this is done, some losses will have been sustained, even though the pieces were served from trenches. Since it is not likely that the guns will be disabled by shell fire, and shrapnel works little injury to the material that will be sufficient to interrupt the fire, it follows that a superiority in artillery on the part of the attack cannot do more than *temporarily* silence the artillery of the defense. This can best be done by shrapnel. When the artillery of the defense is thus forced to cover, the material will be undamaged though the personnel has suffered. This last can be recruited quickly from the nearest line of troops, and the artillery will still be ready for action, and can reappear with all its guns against the infantry of the enemy when at the decisive moment the latter advance to the attack.

Thus also the artillery of the defense, if properly handled, can be made to render valuable aid when the decisive struggle comes, since the cannoneers sitting in the trenches have been more or less proteceted against shrapnel fire.

It appears therefore that field artillery is powerless against objects protected against a greater angle of fall than that of the projectile fired. It can only avail when the defenders are in trenches or behind parapets which fall off on the side away from the enemy at an angle under 20° to 30°, and thus, not covered from the artillery fire, they are shaken when the decisive attack comes.

The history of war furnishes proof for the statement that field guns fail against field fortifications and troops under cover. In the American Civil War, field guns proved quite inadequate, and in the Turko-Russian War the Russians at Plevna could gain no success with 170 field guns against the 100 of the Turks. Later on the Russians brought up 20 siege guns which played on the gradually strengthened works of the Turks, but with no better success. Before their third unsuccessful assault the Russians cannonaded the Turkish works for several days with 450 pieces, to which the Turks as before could reply with only one hundred; but in spite of this superiority in guns, the Russians had nothing

to show for it, for the Turkish infantry took to cover against the artillery fire, and when cover was not at hand for their artillery, it changed its position from time to time, compelling the Russians to a protracted unavailing cannonade.

This work of the artillery gained the Russians nothing but brought many direct disadvantages. Kuropatkin sums them up thus in his "*Kritische Rückblicke auf den russisch-türkischen Krieg*, 1877-78"; 1. As regards material, the Russians wasted 20,000 projectiles, and many guns and other material were rendered unserviceable; 2. the Russians lost much in morale, in the conviction that the fire of their artillery, on which they based many hopes, was ineffectual; 3. the artillery lost confidence in its leaders, in its guns, and in itself; and 4. the infantry gave up hope of receiving aid and support from the artillery; 5. finally valuable time was lost, as a consequence of the unprofitable work of the artillery.

On the other hand the Turks gained in many respects: first, in morale, the Turks were convinced of the failure of the more numerous Russian artillery; second, in material, they lost few men, their works suffered little in resisting capacity, and they found they were able to establish new fortifications under the very eyes of the Russians.

When the Czar, after the Russians had lost 30,000 men before Plevna, gave the command to General Todleben, the successful defender of Sebastopol, this general raised the strength of the artillery up to 508 field and 45 siege guns; but this great array of guns was unable to do more than render it more difficult for the Turks to strengthen their works by day. The insufficiency of long cannon firing against field fortifications, even when the caliber of the guns classes them as siege guns, is clearly shown by the fact that Osman Pasha did not surrender until three months later, and then only on account of the failure of victuals and ammunition, after being quite hemmed in by the Russians.

The Turko-Russian War furnishes other examples than Plevna of the inadequacy of long cannon. At Gornji-Dubniak four thousand Turks with 4 guns defended a site strengthened by rifle pits and 2 redoubts against 20,000 Russians, who surrounded their position and bombarded them for half a day with 60 guns. Though the profile of these works was weaker than that of the works at Plevna, the assault of the Russians that followed their cannonade was repulsed. Though new columns were led to the attack, it was not until darkness began to fall, that the Turks

failing to receive assistance from their main army, were driven off the field or taken prisoners. Nevertheless their losses were not great, while those of the Russians amounted to 3,300 men, nearly as much as the whole strength of the garrison.

The result was the same at Telish, where 56 Russian guns fired against the intrenched position of 5 Turkish battalions for nine hours, and accomplished almost nothing.

It was stated in the account of Plevna that the siege guns that the Russians brought up had no especial effect. Of course by the time the Russians had brought up these heavy guns, the works had no longer entirely the character of field fortifications; for the profile of fortifications will naturally be strengthened when the enemy waits not merely a day, as is generally the case in the field, but is held at bay for weeks and even months. Especially in strength of parapet and increased cover for the defenders light fortifications will assume more or less the character of semi-permanent works. As this change progresses the possibility diminishes of acting successfully with field guns against the defenders of such works.

Long cannon of large caliber in spite of the increased energy that comes with their flat trajectory are not much more effective than field guns, for while they are good against vertical targets, they are not so against horizontal targets, and troops sitting in shelter trenches must be regarded as horizontal targets. Moreover the strongest line of resistance of the parapet protecting the defenders is directly in the line of the projectile's trajectory. The caliber of guns capable of transportation in the field is not, as a rule, sufficient to destroy this shelter; so heavy guns, with a trajectory still flatter than that of the field guns, are equally unsuccessful in attaining hidden targets.

Not only does this fact weigh against the supplementing of the fire of field guns by that of long heavy cannon, but it must also be remembered that while these heavy guns can be moved easily enough along well paved roads, yet their mobility is uncertain when they leave the roads and are sent across country. Arms of offense that in the field are moved at a slow pace and with much difficulty are of little value in the quick changing phases of a campaign. If the ground was soaked by a long rain, they would stick in the mud. They could not therefore fulfil the requirements imposed on field and likewise in this case on these long heavy cannon, *viz.*, *to open fire at the right time from the right place.*

Still other considerations work against the use of long heavy

cannon against hidden targets. Among these are, the difficulty of supplying ammunition and their slowness of fire.

For a caliber of 15 cm. (5.9 inches) the projectile weighs about 40 kg. (88 lbs.), for one of 12 cm. (4.72 inches) about 20 kg. (44 lbs.). As the limber cannot be loaded to an extent that will interfere with the mobility of the piece, we may estimate 8 rounds with the gun for the 15 cm. caliber, and twice as many for the 12 cm. caliber. Likewise the caisson of the 15 cm. gun will carry 8 rounds in its limber and 16 rounds in the caisson-body, in all 24 rounds; the 12 cm. gun will carry twice as many. In long engagements there would be a danger of the ammunition running out if a reduction in the rapidity of fire did not ensue when the caliber is increased, for it becomes more difficult to bring the ammunition up to the guns in the first line, and the loading and aiming requires more time. The evil might be partially remedied by increasing the number of caissons assigned to each battery, but on the other hand this would unduly lengthen out the column, especially with the 15 cm. gun.

In a contest between a heavy battery of long cannon and field guns, the former would be at a disadvantage on account of their slower rate of firing. A field battery delivers ordinarily 4 rounds per minute; this may rise as high as 15 rounds in the exigency of battle. A 15 cm. (5.9 in.) battery, on the other hand, standing on platforms delivers about one shot in three-fourths of a minute; without platforms, the rate would be still less. In spite of the far greater number of bullets that each shrapnel of the larger caliber carries, the field battery will reply in a given time with a greater number, and the issue of such a duel cannot remain doubtful, for it rests on disabling the cannoneers.

From all that has now been said it follows, that neither field guns nor long heavy cannon, firing shell or shrapnel, are capable of shaking troops protected against an angle of fall greater than that of the projectile, nor are they able to prevent an active defense when the decisive attack is made. The destruction of the earth works of the defense is not possible even with heavy guns. These heavy guns firing against troops under cover are, on account of their flatter trajectory, not only not better, but generally inferior to an equal number of field guns, and in the artillery duel this relation does not change. To this inferiority must be added their greater weight. It must be kept in mind, however, that we are speaking of the employment of heavy cannon on the offensive, not on the defensive. With the latter, the conditions are much more in favor of the long cannon.

III. THE EFFECT OF CURVED FIRE CANNON AGAINST CONCEALED OBJECTS.

Troops sitting with their backs against a parapet are just as ready for action as those standing in the trenches; in case of an attack, the former need but to stand on the banquette and open fire. To avoid shrapnel fire therefore from long cannon, troops remaining in shelter trenches will quickly take advantage of the protection the parapet offers them. They thus become horizontal targets for the attacker, and must be reached with artillery in order that the effect of their fire will not be felt by the offensive at a time when it would be most unseasonable and mischievous.

Now the probability of hitting horizontal targets increases with the angle of fall; and for smaller ranges, only howitzers and mortars have a large angle of fall. Hence these species of cannon appear best adapted for the horizontal target.

Just as ever, it will still be the rule in a campaign that the targets of artillery will be vertical and in the open; but in exceptional cases, the garrison of shelter trenches will take cover and the guns be withdrawn. Both of these conditions must be prepared for; and this would be done, if, to the larger number of field guns that an army carries in the field, there was added a small number of curved fire cannon. And were this done, it would be but returning to an organization which we already once possessed; for in the days of spherical shell, in addition to the long guns which were their main armament, the field artillery was also supplied with howitzers to seek out objects in dead angles.

Returning now to the lessons of the history of war, we find the following facts based on an account by an officer of artillery in the Northern Army during the American War of Secession. With the Federal Army were certain Coehorn mortars which were used against the Confederate troops, when the latter were intrenched in field works with strong profile, since it was found that long cannon made no impression on the garrison. The longer the war continued, the more were the utility of these mortars and their ease of conveyance prized. Hence there at last arose a constant pressing demand for Coehorn mortars,—yet these light portable mortars fired only shell.

Especially since the experiences of the Turko-Russian war, military writers have called for the introduction of curved fire cannon to effectively cannonade field intrenchments. Thus Boguslawski says in "*Die Hautpwaffe in Form und Wesen*"; "In

the *Development of Tactics* (Part 2, Vol. 3), I expressed the view that the introduction of an improved curved fire cannon for use in the field against the ever increasing number of intrenchments, was not one of the impossibilities; this opinion did not deserve the fine contempt it received on so many sides.

"It makes little difference whether the curved fire cannon move with the other artillery, or follow in small parks immediately in rear of the army. The idea is the same, and is this,—not only in front of permanent works but also before field intrenchments, as soon as the enemy, after the manner now customary, takes refuge behind ramparts or in trenches, there arises a need, and an immediate need, for howitzers or mortars to open a vertical fire, that can penetrate their overhead cover, and reach the ground close behind the parapets.

"We are fimly convinced that curved fire cannon for field use will again be introduced in one way or other through urgent necessity."

Nearly all military writers now take it for granted that in the next war there will be an extensive use of field fortifications.

The necessity of adding a limited number of curved fire cannon to the long guns of the field artillery is brought out in detail by Major Lydhecker in a paper that obtained the prize in the prize essays for artillery officers 1885-87, and which was entitled: "Curved Fire in field and siege warfare, especially against field intrenchments."

The author of "*Detached Batteries for the Army in the Field*", in the *Jahrbüchern für die deutsche Armee und Marine* (1890), expresses himself thus: "The magazine small-arm justifies every stroke of the spade, for thereby cover is obtained that makes it invincible. Contrary to the state of things in former times, intrenching tools at the present day constitute a capital that bears interest every hour. Hence where the defender in times past allowed the troops to rest in what time was at his disposal, nowadays he will employ it in causing his troops to intrench themselves, rightly judging that the sweat of the brow before the battle will in large measure control the fate of the day. It is probable then that in a future war unprepared battle fields will be the exception, and in many of them the changes wrought in the plan and profile of the terrain will be of considerable magnitude. To shake and weaken the defender's power of fire, which is necessary to prepare for the decisive attack, becomes a peculiarly difficult problem for the artillery."

It is further shown in this essay that curved fire pieces are

effective even when the projectiles pass clear over the shelter; so that the possession of such special pieces becomes indispensable for an army in the field. A piece with a steeply curved fire is to be preferred, for this has the further advantage that the attacker can advance close up to the lines of defense, while these are still under fire, without himself running a risk from his own artillery.

The same periodical that contained the foregoing essay. printed in 1894 an article by Major General Speck entitled, "The Direction of the Movement and of the Fire of Heavy Artillery in the attack of fortified lines of defense." In this the author says that there is little doubt that since the Turko-Russian war the strengthening of positions by fortifications will receive an application more extended than ever before. Also, when, in a campaign, opposed to a swift advancing offensive, the defense finds itself suddenly forced to stand and await the attack in an unprepared position, it will still seek to strengthen the position by hasty intrenchments and other means at hand. This situation will no longer be the exception to the rule, and hence the field artillery to overpower such positions must have light cannon with steeply curved fire.

In this respect there has been a complete revolution in siege artillery since twenty-five years ago, at which time its rifled cannon were almost exclusively long guns, rifled mortars first appearing on the stage before Strasburg in 1870. Curved fire from howitzers and mortars has in a large degree replaced long cannon for firing against concealed targets, and on the whole has come decidedly to the front. Accordingly we now find in siege trains destined for the armament of a fortress, a large number of rifled howitzers and mortars. This step could the more readily be taken in siege artillery because,—apart from the better action of curved fire cannon against the numerous concealed targets presented in a siege,—the introduction of these new pieces increased the mobility of a large part of the siege artillery, without impairing the simplicity of its equipment, appurtenances. and ammunition supply.

Lieutenant-General Müller, speaking of the effect of the smooth-bore mortars at Sebastopol in his "Geschichte des Festungskrieges," says: "The mortar fire was very effective on both sides, especially in its destruction of embrasures and platforms; the little Russian mortars were particularly annoying to the attack. In a similar way he speaks of the effect of the remarkably large use of smooth-bore mortars before Strasburg:

"The mortar fire kept on increasing. During the first period of the attack (till September 10) the daily expenditure of bombs rose from about 400 up to 1200 or 1300; at the end of the second period (September 20) it had reached 3000. Of course among these were many quite light ones (15 cm = 5.9 in.), of which latter for example 1644 were fired from the 17th to the 18th of September."

In treating of the period between 1870-1885, after mentioning the increase in effectiveness through using shrapnel for the 15 cm. rifled mortars, the same author says:

"The men and guns in batteries and behind ramparts hitherto secure against all other kinds of fire were now exposed to extermination to a degree unknown before. This power of the mortar came first clearly to light in Germany in 1880, after the 21 cm. (8.27 in.) mortar had been more extensively employed in the maneuvers, and about this time it was demonstrated that the fire of heavy mortars destroyed a battery more rapidly than a direct fire from 12 and 15 cm. (4.72 and 5.9 in.) cannon."

General von Sauer expresses his views in his works of the early eighties thus: "Many conditions for the defense have been totally changed by the introduction of rifled mortars. For the artillery attack of fortifications, the chief reliance between the ranges of 4000 and 2000 m. (4400 and 2200 yards) must be placed on mortar and shrapnel fire."

He remarks in his "Beiträgen zur Taktik des Festungskrieges": "Could the opening of the artillery attack at once follow the investment, there would be a marked shortening of the attack. For this purpose field artillery would have to be employed, and this would have to possess howitzers."

For the period since 1885 Lieutenant-General Müller says: "The system of cannon of the large artilleries described for the preceding period now received a change in its composition; curved fire pieces were increased in number, those with flat trajectory were diminished."

From what has been cited it will be seen, that in *siege artillery* curved fire cannon have achieved a constantly increasing importance at the expense of the long guns, due to the increased shelter both as regards the angle of fall of the projectile and the actual resistance of the cover itself.

What is true of the effectiveness of plunging fire in the siege and defense of permanent works will also hold good in a campaign. Indeed plunging fire will perhaps be more effective here

in so far as the targets are either living or if material are of comparatively little resistance (as guns and light overhead cover); it wiil perhaps be less effective, on the other hand, since the objects shot at are not so broad or so deep as with siege artillery.

Before giving examples of trials that have taken place with the object of comparing the effect of field guns and field mortars, we will first examine the mode of attack on field fortifications when curved fire cannon accompany the army in the field.

The troops behind cover are exposed to the curved fire during the whole time preceding the infantry attack. They are under an effective shrapnel fire whether sitting behind the parapet or in the case of infantry when standing upon the banquette. In the latter case the long cannon might share in the firing, if the infantry of the attack has not advanced so far as to be in danger from their own artillery fire (300-400 m., 330-440 yards). In this event, however, the curved fire can be maintained against the same objects as before, because in consequence of the great angle of fall the longitudinal dispersion of the shrapnel is small, even when the point of bursting of the shrapnel is comparatively high. Supported by this continuing fire the infantry of the attack can advance nearer than 300 m. (330 yards) to the enemy's position, because by a small increase of the elevation and length of fuze, the shrapnel can be made to burst so that none of the bullets fall in front of the parapet, while on the ground close behind it they fall thickly. Hence precisely at the critical moment of the attack the foremost line of the defense and the reserves coming forward to its support can be held in check.

If the attack is defeated, the reverse will be less serious if curved fire is thus present than if the artillery consisted exclusively of cannon that must cease firing at the most critical moment, or else, by increasing the elevation, fire several hundred yards behind the line at supposed reserves who at this time may be close up to the front line.

It cannot be doubted that curved fire will give a sufficiently large angle of fall to successfully cannonade concealed targets, since the 15 cm. (5.9 in.) mortar with lesser elevations and corresponding loading gives an angle of fall of over 30° at 1700 m. (1880 yards), and the 15 cm. howitzer gives the same angle at 2600 m. (2850 yards). When these pieces are fired with shrapnel, the angle of fall of the complete projectile must be increased by half the angle of the cone of dispersion. With a small final velocity the total angle of the cone is about 30°. Hence, the

steepest requisite angle of fall (45°) for the shrapnel is obtained at medium ranges.

We will now give some comparative trials of field gun and mortar firing. These tests took place in Russia in 1882; they were made against an earth-work with 244 targets representing the defenders.

Piece and Ammunition.	Number of hits in targets representing cannoneers.
1.—108 shell and shrapnel from 12 light field guns.	30
2.—144 shell and shrapnel from 16 heavy field guns.	40
3.— 72 shell and shrapnel from 4 light and 4 heavy field guns.	7
4.— 40 shell from two 15 cm. mortars.	19
5.— 40 shell from the 10.67 mortar.	7

The range is missing in this table, but it is likely that it was the same for all five firings; otherwise there could be no comparison of them. It is also to be noticed that in the first three firings, both shell and shrapnel were used, but it is not stated how many were shell and how many shrapnel. Probably shell was employed to get the range, and the fire continued with shrapnel as the more efficient projectile. With the mortars, on the other hand, only shell is used, apparently because the construction of shrapnel for mortars was not settled at that date. While the five firings are thus open to objections, yet as far as so small a number of shots permits, we may draw some inferences.

Taking the hits made in the fourth firing as the standard, at the same ratio of hits per shot there would have been 51 hits in the first firing, 68 in the second, and 34 in the third. In other words, this signifies that the mortar was more effective.

The work of the 10.67 cm. (4.2 in.) mortar is considerably behind that of the 15 cm. (5.9 in.) caliber; it is better than the third firing however, though it falls behind the first and second. This inferiority is due to the fact that the smaller caliber mortar does not fire as accurately as the large caliber, and its shell does not give as many pieces on bursting; moreover the mortars were firing shell, and not shrapnel, which is so much more effective. If shrapnel had been used, it is not unlikely that the effect of the fourth firing would also have been greater.

A more severe comparison of these trials might be made, not based on the number of shots and their effect, but on the weight of metal fired; ths firings number 4 and 5, would here be superior. The comparative numbers for the five firings are these:

for one shot fired, the hits are in order 0.27— 0.28— 0.1— 0.5 and 0.17; for a hundred weight of metai, 2.25— 1.2— 0.51— 1.2 and 0.42. The work of the 15 cm. (5.9 in.) mortar is in this last case as good as the firing of No. 2, in spite of the fact the mortar fired only shell. That shrapnel is effective against such concealed targets some examples that are given further on will amply prove.

We will now give the effect of the projectiles in the above trials against the material. The following numbers give the relative value of the destructive effect on the material, of these five firings in order; corresponding to one projectile fired, 0.1— 0.23— 0.125— 4.5— 1.0; for one hundred weight of metal, the relative values are, 0.9— 1.02— 0.66— 9.9 and 2.4. Here the shell fired with percussion fuze naturally is more effective than the shrapnel.

A further comparative trial in Russia again shows the superiority of curved fire over horizontal fire against concealed targets.

	Range. m.	Piece and Ammunition.	Number and kind of Targets.	Targets Damaged. total.	Targets Damaged. per shot.
	1600	Heavy gun, 18 shell.	59 standing	7 standing	0.25 standing
		Light gun, 18 shell.	59 sitting	0 sitting	0 sitting
	1600	Heavy gun, 18 shrapnel.	Same	5 standing	0.14 standing
		Light gun, 18 shrapnel.		6 sitting	0.16 sitting
Mean of four firings.	1600	15 cm. mortar, 20 shell.	Same	? standing 4.5 sitting	? standing 0.22 sitting
	1600	10.67 cm. mortar, 20 shell.	Same	? standing 4.75 sittnig	? standing 0.23 sitting

In the above table it is not stated against what angle of fall the standing and sitting targets were protected, we cannot therefore draw any certain conclusions respecting the power of the two kinds of firing. The test seems to indicate however that the mortars firing shell are very nearly equal in effect to the guns firing shrapnel.

About ten years ago, Krupp made some experimental tests of 12 cm. (4.72 in.) field howitzer and 15 cm. (5.9 in.) field mortar fire. The target was one used for testing siege guns, and consisted of a sunken battery for six guns. Two of these last (numbered 5 and 6) were in a row at right angles to the line of fire, the other four were in a row at an angle of 45° with the first

two. The object of this disposition was to compare frontal and half lateral fire in attacking a position. In the test we now speak of, only shrapnel was used. The targets for the most part were protected against only very small angles of fall; such targets as had protection against an angle as much as 22° showed little damage; none of the targets were protected against an angle of fall as great as 30°. Corrections were also made on the basis of observations on the target, which of course could not at all be done in war; moreover the results of the shrapnel with 16 g. and 26 g. bullets are combined. The guns had each 7 targets representing cannoneers. The parapet was 2 m. (6½ ft.) high, and at its foot stood some targets 1.8 m. (5.9 ft.) high, which were protected against an angle of fall of 22½° (how many of these is not stated). The targets representing the men at the guns were protected against an angle of fall of 9° or 10°. Of the targets at the four guns oblique to the line of fire (numbered 1 to 4), those targets up against the parapet were protected against 15°, the foremost targets representing the cannoneers, at guns No. 1, 2 and 3, were protected against an angle of fall of 9° or 10°. Numbers 1 and 6 of the guns being on the flanks were the least shot at, in order to increase the probability of hitting. The record was divided thus, (*a*) number of cannoneers hit, (*b*) total number of hits in these targets, (*c*) hits in the vicinity (between the men and four yards back), (*d*) hits in the targets at the foot of the parapet. The height and horizontal distance of the point of bursting is measured from the interior crest of the front parapet.

I. 12 cm. (4.72 in.) howitzer. Weight of shrapnel 16.3 to 16.6 kg. (35.9-36.5 lbs.). Contents, 460 hard lead bullets of 16 g., or 285 bullets of 26 g. Bursting charge, 200-215 g. (7 to 8 oz.). Initial velocity with 0.5 kg. (1.1 lb.) of coarse grained powder ($\frac{6}{10}$ mm.), was 140 m. (460 ft.); with 0.6 kg. (1.32 lb.) powder, initial velocity was 161 m. (528 ft.); with 1 kg. (2.2 lb.) powder, 225 m. (738 ft.); with 1.5 kg. (3.3 lb.) powder, 290 m. (950 ft.).

Firing at 1500 m. with the 12 cm. howitzer.

Charge.	No. of shot	Weight of bullet.	Elevation degrees.	Lateral allowance.	Time of fuse.	Point of bursting.			HITS.							
									At Piece No.						Total.	In the battery.
kg.		grm.		points.	sec.	height	hor. dis.		I	II	III	IV	V	VI		
0.5	1	16	22.5	22	11.0	—40	16	a	3	1	2	5	6	—	17	77
								b	3	2	2	5	9	—	21	
								c	7	5	7	10	13	—	42	
								d	—	—	2	4	8	—	14	
	2	16	22.5	25	11.0	—60	15	a	—	1	—	2	4	1	8	34
								b	—	1	—	3	5	4	13	
								c	—	2	2	6	5	3	18	
								d	—	—	1	1	1	—	7	
	3	26	22.5	22	11.0	—50	14	a	1	—	2	2	—	1	6	41
								b	1	—	2	4	—	1	8	
								c	2	4	3	12	5	—	26	
								d	—	—	—	5	1	1	7	
	4	26	22.5	22	11.0	—45	11	a	—	1	—	—	—	—	1	12
								b	—	1	—	—	—	—	1	
								c	—	1	—	3	1	2	7	
								d	—	1	3	—	—	—	4	
	5	26	22.5	25	11.0	—60	14	a	—	1	2	4	4	—	11	33
								b	—	1	2	5	4	—	12	
								c	—	1	3	9	7	—	20	
								d	—	—	—	1	—	—	1	
1.0	6	26	8.6	8	6.5	—160	16	a	—	—	1	1	3	—	5	10
								b	—	—	1	1	5	—	7	
								c	—	—	—	1	2	—	3	
								d	—	—	—	—	—	—	—	
	7	26	8.8	8	7.0	—60	11	a	—	—	—	—	—	3	3	4
								b	—	—	—	—	—	3	3	
								c	—	—	—	—	—	1	1	
								d	—	—	—	—	—	—	—	
	8	26	8.7	0	7.2	—25	4	a	—	—	3	3	2	1	9	41
								b	—	—	4	8	6	1	19	
								c	—	1	3	10	5	—	19	
								d	—	—	—	3	—	—	3	
	9	16	8.7	0	7.1	—40	8	a	—	1	3	6	2	—	12	54
								b	—	1	3	8	5	—	17	
								c	—	2	3	20	5	—	30	
								d	—	—	—	7	—	—	7	
	10	16	8.7	0	7.1	—45	8	a	—	—	2	5	4	—	11	55
								b	—	—	2	17	6	—	25	
								c	—	5	6	5	3	—	19	
								d	—	—	—	10	1	—	11	

If we add the numbers opposite a and d for each charge, we find for the 0.5 kg. (1.1 lb.) loading at 1500 m. for the five shots, 43 cannoneers and 29 of the infantry at the parapet were hit; for the 1.0 kg. (2.2 lb.) charge at same range and for same number of shots, 40 cannoneers and 21 infantry were hit. Summing up the total number of bullets striking within the limits of the battery, we find 197 for the 0.5 kg. charge, and 164 for the 1.0 kg. charge. It is to be observed that the cannoneers at the siege battery here used as a target are crowded together in half the space the men of a field battery would occupy. The effect of each shot was increased by this.

Firing at 1900 m. with the 12 cm. howitzer.

Charge.	No. of shot	Weight of bullet.	Elevation (degrees).	Lateral allowance.	Time of fuse.	Point of bursting.			HITS.							
									At Piece No.						Total.	In the battery.
kg.		grm.		points.	sec.	height	hor. dis.		I	II	III	IV	V	VI		
0.6	1	16	25.1	25	13.5	—50	0	a	Too short.							
								b								
								c								
								d								
	2	16	26.3	25	13.5	—60	23	a	To the right, 88 hits in 33 m. length.							
								b								
								c								
								d								
	3	16	26.3	40	13.5	—60	25	a	1	2	—	1	—	—	4	15
								b	1	2	—	1	—	—	4	
								c	2	3	5	1	—	—	11	
								d	—	—	—	—	—	—	—	
	4	16	26.1	50	13.5	—35	6	a	—	1	—	—	—	3	4	7
								b	—	2	—	—	—	4	6	
								c	—	—	—	1	—	—	1	
								d	—	—	—	—	—	—	—	
	5	16	25.4	30	13.4	—50	8	a	1	—	3	1	—	—	5	32
								b	1	—	4	1	—	—	6	
								c	9	8	6	1	1	—	25	
								d	—	—	1	—	—	—	1	
	6	26	25.4	35	13.4	—60	18	a	—	1	1	6	5	—	13	38
								b	—	1	1	7	8	—	17	
								c	—	—	3	5	9	1	18	
								d	—	—	—	1	2	—	3	
	7	26	25.4	40	13.4	—25	9	a	—	1	1	4	7	—	13	126
								b	—	1	1	7	30	—	39	
								c	—	—	5	24	43	—	72	
								d	—	1	—	4	10	—	15	
	8	26	25.4	40	13.4	—40	18	a	—	—	—	2	2	3	7	43
								b	—	—	—	2	4	3	9	
								c	1	4	—	8	7	9	29	
								d	—	—	—	1	4	—	5	
1.0	9	16	12.1	12.0	9.3	—90	14	a	2	1	1	2	—	—	6	10
								b	3	2	1	3	—	—	9	
								c	—	—	—	1	—	—	1	
								d	—	—	—	—	—	—	—	
	10	16	12.1	12.0	9.5	—55	13	a	—	—	3	5	5	—	13	49
								b	—	—	4	13	6	—	23	
								c	—	3	4	11	8	—	26	
								d	—	—	—	—	—	—	—	
	11	26	12.0	12.0	9.5	—10	5	a	—	1	—	1	2	—	4	19
								b	—	1	—	1	2	—	4	
								c	—	—	—	8	7	—	15	
								d	—	—	—	—	—	—	—	
	12	26	12.0	12.0	9.5	— 2	0	a	—	—	—	—	4	—	4	137
								b	—	—	—	—	58	—	58	
								c	—	—	—	—	79	—	79	
								d	—	—	—	—	—	—	—	

With the 0.6 kg. (1.32 lb.) charge at 1980 m. range for 6 shots, 46 cannoneers and 24 infantry at the parapets were hit; for the 1.0 kg. (2.2 lb.) charge for 4 shots 27 cannoneers, but no infantry were hit. In the entire space of the battery there fell 255 bullets in the first case, and 215 in the second and one gun was disabled.

II. The 15 cm. (5.9 in.) mortar. The shrapnel weighed 31.55 to 31.75 kg. (69 to 70 lbs.), containing 500 hard lead balls of 26 g. weight. The bursting charge was between 310 and 410 g.; initial velocity for 0.75 kg. (1.65 lb.) charge was 135 m. (445 ft.) 1.0 kg. (2.2) lbs.), 163 m. (534 ft.).

Firing at 1500 m. with the 15 cm. mortar.

Charge.	No. of shot	Elevation (degrees).	Lateral allowance.	Time of fuse.	Point of bursting.		HITS.								
							At Piece No.							Total.	In the battery.
kg.			points.	sec.	height	hor. dis.		I	II	III	IV	V	VI		
0.75	1	25.3	25	11.6	—75	22	a	—	3	1	2	3	3	12	45
							b	—	3	1	2	3	3	12	
							c	—	3	7	3	6	10	29	
							d	—	—	1	3	—	—	4	
	2	25.3	25	11.6	—55	20	a	—	2	4	3	3	—	12	65
							b	—	2	5	3	3	—	13	
							c	9	5	9	9	6	1	39	
							d	1	2	5	3	2	—	13	
	3	24.8	25	11.6	—60	16	a	1	1	2	—	1	—	5	56
							b	3	1	2	—	1	—	7	
							c	11	8	6	5	7	2	39	
							d	1	2	4	—	3	—	10	
	4	24.8	25	11.6	—60	14	a	—	1	3	2	1	—	6	21
							b	—	1	3	2	1	—	7	
							c	4	1	3	4	1	—	13	
							d	—	—	1	-	—	--	1	
	5	24.8	25	11.6	—70	16	a	2	—	1	6	1	—	10	46
							b	2	—	1	9	2	--	14	
							c	4	4	3	9	4	—	24	
							d	—	—	—	7	1	—	8	

Firing at 1975 m.

Charge.	No. of shot	Elevation (degrees).	Lateral allowance.	Time of fuse.	Point of bursting.			I	II	III	IV	V	VI	Total.	In the battery.
	6	23	30	12.7	—75	18	a	—	1	1	4	1	3	10	68
							b	—	2	1	5	1	3	12	
							c	2	7	6	14	10	8	47	
							d	—	—	—	4	3	2	9	
	7	23	25	12.7	—80	20	a	—	2	1	2	3	2	10	68
							b	—	2	3	3	3	2	13	
							c	2	9	10	8	10	10	49	
							d	—	2	2	2	—	—	6	
	8	23	25	12.7	—70	22	a	1	1	3	—	—	—	5	42
							b	1	1	3	—	—	—	5	
							c	4	9	7	10	3	3	36	
1.0							d	—	—	—	1	—	—	1	
	9	22.8	25	12.7	—65	16	a	—	3	3	5	3	—	14	67
							b	—	4	5	7	4	—	20	
							c	5	7	12	11	5	—	40	
							d	—	—	1	4	2	-	7	
	10	22.8	25	12.7	—75	18	a	1	3	5	2	—	3	14	69
							b	1	3	7	3	—	3	17	
							c	8	13	9	9	5	2	46	
							d	—	1	3	2	—	—	6	
	11	22.8	25	12.7	—55	14	a	6	5	3	5	5	—	24	88
							b	6	5	5	7	8	--	31	
							c	10	11	12	5	8	—	46	
							d	1	1	3	4	2	—	11	

With the 0.75 kg. (1.65 lbs.) charge at 1500 m. (1640 yds.) for five shots, 45 cannoneers and 36 of the men at the parapets were hit, for the 1.0 kg. (2.2 lb.) charge at 1975 m. (2160 yards) for six shots, 77 cannoneers and 40 of men at the parapet were hit. At the 1500 m. range, 233 bullets fell within the limits of the battery; for the 1975 m. range, 402 bullets fell within these limits.

If we reckon here on the basis of the weight of ammunition fired, we find for the 12 cm. (4.72 in.) howitzer at 1500 m. for the 0.5 kg. (1.1 lbs.) charge, that 0.47 cannoneers and 0.25 infantry soldiers were hit per 1 kg. of iron. If we take the 100-weight as our unit in order to compare the results with the Russian firing, we find 26.0 cannoneers and 17.5 infantry hit per 100-weight of metal for the less charge, and 23.5 cannoneers and 12.5 infantry hit for the greater charge. The results for the 1980 m. range are likewise good as regards the number of cannoneers hit; for the larger charge, however, no infantry were hit at this range.

For the 15 cm. (5.9 in.) mortar at 1500 m. range with the smaller charge, we find 0.28 cannoneers and 0.22 infantry hit per 1 kg. of iron; for the larger charge, 0.40 cannoneers and 0.20 infantry were hit. With a 100-weight as the unit, we find these four numbers, 14.0, 11.0 20.0, 10.0.

These numbers seem to indicate that shrapnel fired from mortars and howitzers with an approximately correct adjustment of the point of bursting has tenfold the effectiveness (in a cross-section) of shell fired from the same pieces. Of course there were not enough shots fired to warrant a final conclusion; for this a far greater number of projectiles must be fired, and war conditions simulated.

From the Krupp tests, the howitzer seems a little superior to the mortar. Between guns on the one hand, and mortars and howitzers on the other, as we have shown in sections II and III, the latter class of cannon are undoubtedly superior, at least so far as the small number of comparative trials that have taken place permits us to draw any conclusion. The only question would be whether such or similar results in firing would be obtained under war conditions.

[Translated by Second Lieutenant *George Blakely*, Second Artillery.]

(TO BE CONTINUED.)

NATIONAL DEFENSES.

BY MAJOR-GENERAL MAURICE.*

We have to thank a great American writer, Captain Mahan, for an historical lesson as to the conditions under which Britain had to fight in the past. He has shown that as long as she was supreme at sea, attacks upon her commerce, though they might severely wound her, could not prevent her from striking far more deadly blows at an opponent than any that could be delivered against her. The fact of an opponent being reduced to a war against commerce implied such a disadvantage to him that though the struggle might be long and hard, the Mistress of the Seas was practically certain to emerge from it victorious and with large compensations for her many losses.

His history of the great struggle of our forefathers against the power of Napoleon cannot be too strongly commended to the careful consideration of all those who would wish to realise the position of Britain to-day. But it is necessary also to realise the effect of the changes that have taken place since that great struggle occurred.

In the first place, the conditions of life upon the Continent have altogether changed. The creation of railways, telegraphs, and other means of communication, as well as the development of commercial life, have no doubt made Continental nations in some respects far more independent of the sea, for the actual means of living, than they were in the days of Napoleon. But, on the other hand, the habitual consumption of articles of tropical produce, coffee, sugar, tea, has become universal, and for these and many other things sea transport is still indispensable. It may almost be doubted whether, taking all things into consideration, more especially the developed necessities of civilisation, the loss of all sea transport would not be felt more severely in the present time than it was then. On the other hand, the whole peace conditions of the Continent have been prepared and adapted for war to an extent that was hardly possible even during the long reign of war from 1789 to 1815. Taking, however, into account the way in which the forces on the Continent are now arrayed against one another, it may be reasonably doubted whether the power of Britain, if it be properly used in behalf of

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the liberties of the world, is not still as great, except in one respect to be noted immediately, as Captain Mahan has shown that it was during the great war. The forces, therefore, which are apt to impress British men with the idea that we are already reduced to the position of a state like Belgium, and can only look on in helpless impotence at the struggles of stupendous masses, are by no means so invulnerable to the pressure of Britain as they are apt to be assumed to be.

The one exception which has to be made against our present condition in comparing our power then and now is continually forgotten. Captain Mahan has admirably brought out the facts. The supreme position which our Navy occupied during the great war was by no means due to any natural inaptitude on the part of the French for naval operations. During the immediately preceding struggle, we had lost the American Colonies because we had lost the command of the sea. In the beginning of the Revolutionary War the French Fleet had been reduced to complete inefficacy by the disorders in France. After a few feeble attempts to maintain its position under these circumstances in the open sea, it was driven into harbors where it was impossible for it to keep up its fighting efficiency. It it therefore absurd to look upon this as representing in any way the necessary permanent relation between the two Navies.

Among the elements, therefore, of possible future danger with which we ought to reckon, is the undoubted high efficiency of the present French Fleet. To live upon a tradition of the past which shows us everywhere during that particular war inferior numbers of British ships driving before them, or destroying, French fleets, is a dangerous misconception of history. We may hope everything from the skill and valor of our own sailors; we have no right to assume that those qualities will not be found among the French.

Not a few calmly-thinking French sailors believe that the change which has taken place in the nature of ships since 1815 has tended very greatly to the advantage of their own navy. They say, not without much reason, that the direct influence on naval success of the more seafaring character of our population and of the greater hardihood and physical vigor which they frankly attribute to our sailors, was much more certain in those days than now. They consider that a time has come when mechanical skill in construction, and the influence of the engineer, have become far more potent factors than strictly seafaring skill. It is a question on which it is impossible to pronounce without

the dire experiment of war. But it is right, in considering the whole of the situation, that British men should realise that that view has to be taken into account.

Furthermore, the development of British free trade has so greatly increased the proportion in which our population depends for food from abroad since those times, that it may be doubted whether in studying Captain Mahan's statement of the case we ought not to allow for the increased pressure that would be put upon us by anything that threatened the sources of our food supply. Considering, however, the way in which that one side of the question has been pressed upon us of late years, it is not a little consolatory to have laid before us, with Captain Mahan's impartiality and as a result of his admirable research, the fact, that our enemies early in the great war looked forward with complete confidence to their being able to bring Britain to her knees by attacks upon her commerce alone, even after they had themselves lost the power to contest our supremacy at sea. Captain Mahan has shown clearly that it was the utter failure of this attempt during all the earlier period of the war which made Napoleon face risks, the nature of which he fully realised, in order to prepare for making an actual descent upon our shores.

The development of British commerce has become so enormous that it now presents a much more vulnerable mark to an enemy than it did during the Revolutionary War. We may therefore admit that we are only able to judge from the lesser to the greater, and to treat the experiences of that war as a lesson on a relatively small scale, so far as the immunity of our present commerce from the attacks of petty depredators is concerned. Nevertheless I do not myself believe that any one who will be at the pains to weigh all that Captain Mahan has to urge upon the subject, can fail to realise that his historical evidence has introduced a consideration which has been too much forgotten in the controversies of late years. On the whole, his history tends to show that if we take adequate precautions for the protection of our commerce during war, the percentage of loss which we are likely to incur, though it may be very inconvenient and serious, will not be deadly. Relatively, therefore, this demonstration enchances the importance of the question of invasion; for if attacks upon our commerce will not be decisive of anything, a nation which wishes to crush us will be forced to attempt invasion or to accept a position of great disadvantage. It is therefore necessary to discuss all the more earnestly those conditions which tend to affect the possibility of direct invasion of our shores.

This is very important, because there has been a tendency of late years among some of our naval writers to scoff at the idea of our maintaining any "second line of defense" at all. Their argument has been, that if the Navy be supreme upon the seas, there can be no risk of invasion whatever. If the Navy be not supreme then Britain must starve. Now the effect of Captain Mahan's work is to show that the process of "starving" Britain would be, to say the least of it, a very slow and difficult one. On the other hand, despite the changes which have to be taken into account in the conditions of both land and sea fighting, Captain Mahan has shown more clearly than it had ever been shown before, that the question of succesful invasion was even then a matter of only a very few days of local supremacy for an enemy's fleet. What was then necessary to it was not that the supremacy of Britain on the seas should be permanently destroyed, but that during a given period that sepremacy should not be able to assert itself at the right place.*

It may be and it is quite true that had Napoleon succeeded in landing his army upon our coast because there was not sufficient naval force available to resist him, he would still have been liable to find his retreat cut off, and his communications with France severed by the restored supremacy of the British Fleet. It is not the less obvious that the importance of this fact would depend upon the nature and degree of resistance which his forces might meet with in Britain. If he could so completely sweep away all opposition on land as to dictate terms in London, he felt certain of securing his own retreat. He would have been in no worse a position in that matter than he found himself in, in Egypt after the battle of the Nile. Despite the loss of all his communications with France, he was able to effect the capture of Cairo and the complete conquest of Egypt itself. As the conquest of Egypt produced no very serious pressure upon the Mistress of the Seas, his failure at Acre made the ultimate abandonment of Egypt inevitable. Britain could at her leisure land forces in Egypt which would make the position of the French army an impossible one.

It is, however, important to remember that it was only in this indirect way that the command of the sea enabled us even to turn the French out of Egypt. It was the actual land-fighting at Acre and the success of Sir Ralph Abercromby's expedition at Abukir that enforced the withdrawal of the French army. Applying the case to a possible success of Napoleon's in Britain, all

* These views have been amplified with admirable force in Mahan's *Life of Nelson*.

the circumstances are reversed—the pressure would be applied directly to the mistress of the very fleet which endangered his retreat. Had the fleet which threatened Napoleon in Egypt been not British but Egyptian, there can be little doubt that Napoleon would have been able to enforce terms which, if they did not actually involve the surrender of the fleet, would have certainly enabled him to open up his own communications with France.

There is a small school of naval writers who treat it as an insult to our Navy to speak of it as our "first line of defense" and scoff at the idea of there being any use in maintaining our home army, more especially the volunteers and militia. It has happily been repudiated by our most distinguished sailors. No one could have spoken out more strongly on the subject than Sir Geoffrey Hornby did a few years before his death; while Admiral Colomb, who has used expressions that made some of his friends fear that he had committed himself to the views of the school in question, has with equal emphasis repudiated them. It it only, therefore, important to notice the matter in so far as any language of this kind tends to weaken the confidence and zeal of our volunteers, or to furnish a Government with excuses for not supplying them with what is necessary to efficiency.

The difference between Britain maintaining a force at home adequate to resist such an army as could be landed on her shores, and Britain denuded of all home defense—trusting solely to her Navy for protection—is admirably illustrated by the circumstance of Napoleon's expedition to Egypt. If the land force at home were so inadequate that the commander of a hostile army could as completely subdue Britain as, despite the supremacy of our fleet, Napoleon in fact subdued Egypt, the fleet after its first failure to stop the invaders would avail us nothing. If, on the other hand, the invaders were met by a firm and obstinate resistance, terrible as the losses which would be inflicted upon Britain would be, the fate of the invaders would sooner or later be certain, unless the fleet had not only failed us in the hour of invasion, but had permanently lost its supremacy even within the narrow seas. While, therefore, no one can exaggerate the importance, for the safety and the maintenance of the power and the wealth of Britain, of a navy which shall at all times be supreme not only in the narrow seas, but elsewhere, it would be madness to ignore the necessity for an entirely independent system of home defense.

Moreover, as I have often insisted elsewhere, there are avowedly circumstances in the present condition of naval warfare which,

without in the least tending to shake confidence in our retaining our command of the sea if we will make the efforts that are necessary to do so, do make it exceedingly doubtful whether the ablest admiral that we have could guarantee us against a temporary disaster. All sorts of new mechanical forces have come into play since the great war, and no adequate test of their effect has been supplied by recent war experience. I a few years ago publicly put the question at Aldershot to two of our ablest sailors, whether they either of them felt confidence or believed that any one else, whose judgment could be depended upon, did, as to the outcome of the next great naval engagement. Both of them frankly avowed that the complications of the problem were too great for any human foresight. We practically know hardly at all whether the ram, the torpedo, or the big gun are to be the deciding elements of the future warfare. Still less do we know what effect high explosives are likely to produce in naval any more than in land war.

It is said that our best authorities on the subject believe that the difficulties of creating a permanent high explosive have been overcome. That is an element in our favor, the importance of which cannot be overrated. The question involved is so serious a one that, though I have often mentioned it before, I do not think that I ought to omit a full statement for my present readers.

Germany and France both attach so much importance to the effects of high explosive shells that they have spent millions of money upon preparing both to use them and to resist them. Year by year they have continued to store vast materials for the manufacture of these terrible instruments of destruction. France, at all events till lately, made up fresh every year sufficient high explosive material for the loading of all the shells that she will require for a land campaign. I believe she does so still. Germany, in presence of the great array of French fortifications which has been constructed along her frontier, reckons upon the effect of high explosive shells carried into the field for their demolition. Naturally, on a subject which both Governments keep as secret as they possibly can, one cannot always quote the evidence on which one relies for such a statement as this. I am obliged to say this because a certain writer, who shall be nameless, an able man, but one of the least courteous of controversialists, has poured scorn on my words because I have not cited authority for all that I have said. There are times when one can only rely upon the presumption of one's friends that one is not likely either

to be a wilful liar or an extremely careless sifter of evidence. I am as certain as I am of my own existence that if I could quote my authorities my critic would change his tune.

There is at all events one evidence of the importance which the German Government attaches to the matter which there has been no attempt to conceal. Under the eyes of any one who has chosen to see it, under my eyes amongst others, they have been piling, around the forts at Metz for instance, at an expenditure which must have been enormous, debris and materials, into the details of which I need not enter, but so designed as to afford protection against the new shells. Those who are willing to believe that an economical Government like that of Germany throws away money in this sort of way, without the most careful preliminary inquiry as to its necessity, are people with whom it is quite useless to argue.

It is said that we have been carrying out a series of experiments with high explosives, and that several years ago we ascertained the fact that one of them, as effective as the rest, would resist the effects of time and change of climate. What is certain is, that very many years ago the question in France and Germany passed out of the stage of experiment and entered into that of practical preparation for war. What is equally certain is, that in a matter in which the preparation for practical use must take many years, we have not advanced one step beyond the experimental stage.

Now when at Aldershot I put publicly to the most distinguished of our admirals* the question, whether he thought it would be possible for a fleet which possessed no shells filled with high explosives to meet another which had a large supply of them, his answer to me was, that of cource when war came we must at all risk put the high explosive shells on board: that is to say, that we are now, in this position, that we have not ventured past the experimental stage in reference to these explosives at all; that none of our sailors have had any training in handling them; and that so serious is the question that we should at the last moment have to make an experiment under the dire circumstances of war, in a matter on which those to whom we should be opposed had already reached the stage of large practice.

If it be true that our own chemists have succeeded in creating an explosive which is not liable to injury either by jolting about in a waggon or by lapse of time, certainly one great disadvantage of the situation has been removed for us. If we are able to store

* Sir Geoffrey Hornby.

adequate material to have the shells available for issue, and to practise our soldiers and sailors with them, the difficulty involved in the extent of our vast Empire, and the consequent long voyages of our ships, need not trouble us. But at the present moment we are practically in as bad a position as ever, so far as the military use of these terrible new engines of war is concerned. If we have realised their importance, we are like those Athenians who knew what was right, but did not like doing it. If, on the other hand, we are trusting, in the teeth of all the experiments that have been conducted on the Continent, to the results we have obtained at Lydd, then it is necessary to remark that those who have travelled through every country in Europe, to the several experimental grounds of the Great Powers. declare that the investigations which we make on any subject of the kind are so insignificant as compared with those made by others, that they scarcely deserve to be reckoned at all. The wealthiest country in Europe, we skimp the money that is allowed for experiments to an extent that makes only an insignificant fraction of what is allowed by such countries as Austria and Russia. When, therefore, an able man like Sir George Clarke quotes as decisive on this subject "experiments at Lydd," "though it make the unwary laugh, it cannot but make the judicious grieve." Till this question is more satisfactorily settled than it is, we certainly must include among the dangers against which we have to defend ourselves—a possible invasion of Britain.

Even if this particular danger be warded off, it illustrates very forcibly the present uncertainties of naval warfare, and the fact that we do not know what changes may arise as a consequence of the progress of invention.

In regard to invasion generally, perhaps the most permanent risk that we run may be most happily expressed in these only too true words of George Eliot's: "The sense of security more frequently springs from habit than from conviction, and for this reason it often subsists after such a change in the conditions as might have been expected to suggest alarm. The lapse of time during which a given event has not happened, is, in the logic of habit, constantly alleged as a reason why the event should never happen, even when the lapse of time is precisely the added condition which makes the event imminent."

To men who, like myself, have had to go on isolated military duty in different parts of the country, these words come home with a force that is partly comic, and partly pathetic. It is

tolerably obvious that if there be even a possibility of such a temporary failure of the protection of our fleet, as seems at least to be indicated by the conditions which I have explained, then it is only a matter of common prodence that we soldiers should sometimes consider what the circumstances of actual fighting in this country would be. It does not seem to be an exaggerated precaution that we should examine the positions of greatest advantage for our own army, and should endeavor to obtain such information as would be useful in the event of war at home. As a matter of fact this is, of course, systematically done. The conversations that one is not unfrequently involved in in the course of doing it, with local residents, are very suggestive. George Eliot's words might be taken as the text of most of these.

To not a few isolated spinsters and other nervous persons, the mere fact of soldiers considering the question of home defense at all causes so much alarm and anxiety, that they have to put away from them the unpleasant idea with such sentence as, "Oh, of cource I know it's only make-believe; it never would really happen," and so on. And yet it may be doubted if those good folks realise at all the question, whether "it" ever really will happen, depends almost entirely on the success of their navy, and that again on a House of Commons which laughs at high explosives, just as Belinda laughs at Hell.

As I am only engaged in this chapter in considering the different possible modes of attack upon the country, I pass on now to the dangers which threaten other parts of the Empire.

Among these the first place is neccessarily taken by India. That subject has recently been elaborately discussed in the volume by Sir Charles Dilke and Mr. Spencer Wilkinson, of which a new edition reaches me as these words go to press. It has the defect I ventured to point out in regard to the earlier edition, that it ignores the evidence supplied by Sir A. Haliburton's report. No discussion in regard to our present system can be of much value which does not deal with that evidence. I purpose here to set forth certain general principles which seem to me necessary to be taken into account before their very valuable statement of the condition of the frontier of the Indian Empire can be treated as a practical estimate of our right course in war.

That it is from Russia that we are there liable to attack, just as at home it is from France only that we have any serious reason to anticipate any possible attempt at invasion, scarcely needs to be said. To me it seems now, as it has seemed for years, that what we have to dread from Russia is not so much an immediate

invasion of India, as the fact that she is still so remote from India, for purposes of effective action on our part, that she is able continually to make advances which tend very much to increase for her the facilities of ultimate invasion of India, while it is exceedingly difficult for us to interfere with them.

If, for instance, Russia were to choose to seize some of the provinces of Afghanistan beyond the Hindoo Koosh, or were to make up her mind to occupy Herat, it is practically certain that she could do one or the other under the present condition of things before we could interfere with her. Suppose that she did either one or the other, and remained, without further eggression, in tranquil possession of them, we should be, under present circumstances, placed in a position of the very greatest difficulty.

We have given such pledges to the Ameer that we could not, without violation of the honor of our Goverment, refuse to assist the Ameer if he called upon us to aid him in recovering them. In a military sense that would involve us in a campain, not only in itself arduous, but such that we should put ourselves at a great disadvantage as compared with Russia. The march of our troops, all reinforcements for them, their connection with India, and the supplies of food and ammunition that they would require, must run through most difficult country, in which a few hostile tribes acting against them might place us in an awkward position, if not in imminent danger. The mere fact that we entered as allies of the Ameer would not at all secure us against the predatory instincts of banditti nominally under his rule. Any disaster, almost any rumor of disaster, that happened to our troops, in the distant province which we should have to enter in order to fulfil our pledges, would certainly cause the most fierce attacks upon our lines of communication, and make the efficient maintenance of the force at the front a task extraordinarily hard.

Nor can I see what security we should have, even after we had expelled the Russians, that as soon as we went home again they would not immediately re-enter into possession. The occupation of Cabul and Candahar, which is talked of as the necessary consequence of any such action on the part of Russia, would surely not satisfy the Ameer as a fulfilment of our pledge to defend his territory whether beyond the Hindoo Koosh or otherwise.

Yet the alternative is a most difficult one. If we violate our pledges to the Ameer, not only shall we make him a tool in the hands of Russia, but we shall shake all confidence in our word throughout the East. We shall manifestly have promised to do

that which we were not able to do, and have recoiled because of sheer impotence. Furthermore, though perhaps our interest in the territory beyond the Hindoo Koosh is small, on any other ground than that of our pledge to the Ameer, our interest in Herat is very large. In its present condition Herat is probably of little importance to anybody. Developed as it might easily be, and almost certainly would be, for military purposes under Russian rule, it would become, what it always used to be in former ages, the gate of India.

The practical meaning of that figurative phrase is easily explained. The first necessity that has to be secured for Russian action anywhere, but more especially on the confines of India and throughout Asia, is facility of movement and of transport. It is obviously not enough that there should be, somewhere or other, under the command of the Czar untold millions of soldiers. In order that they may effect anything on the confines of India, those that are to fight must be near enough to shoot, and have with them both the means of shooting and the means of living. At very great sacrifice the Russians have carried their railway from the Caspian along the northern frontiers of Persia and of Afghanistan. But the railway is necessarily one along which the transport is slow, and it offers no facilities for the further movement across Afghanistan upon India. If Herat were in the hands of Russia and its military resources fully developed, most of the implements of warfare could be constructed within the province itself. Large supplies of food also for an army could be grown there, and in the settled province large stores also of such things as an army would require, such as could not be procured in the place, could be gradually accumulated. When the process was complete, the change in the situation would in fact be that a Russian army would have to advance either upon Afghanistan, or upon India, from Herat, and would draw all its supplies from it. All the difficulties of the long transport across the Caspian by the narrow-gauge railway, and thence over the roads where there is at present no railway, would be overcome. The position of advantage in which Russia would stand under these circumstances, must, I think, be intelligible to any one even if he has very little considered the nature of military operations.

To sum up, therefore, the case, as it appears to me, stands thus. Supposing that Russia carries on consistently the policy that she has been following for years, she, being nearer both to Herat and the provinces north of the Hindoo Koosh than we are, can occupy them whenever she is not afraid of a general war with

us. We could only turn her out of them at very great cost, with very great difficulty, and with very great risk. To me, therefore, it seems, as it has always seemed, that our true policy is to prevent her from making this attack upon us by taking advantage of the general political situation of Europe. How that can best be done, it will be the object of a future chapter to show. My present purpose is to indicate the fact that the form of attack which we have most to dread from Russia on our Indian frontier is not an immediate invasion of our Indian provinces, but such a gradual advance into positions of future advantage for her, as it will be exceedingly difficult for us to stop by direct action in India.

In two other quarters, other than in Afghanistan, there is menace of this danger. The recent advance of Russia into the Pamirs has attracted much attention ; her stealthy inroads upon Persia very little. Nevertheless, I am myself inclined to think that the Persian question is much the more serious of the two. A few years ago, when Baker Pasha and Sir Charles MacGregor visited the northern frontier of Persia, it was still possible to make a serious impression from that side upon the line of communication of Russia between Merve and the Caspian.

But Russia has been steadily guarding herself against that danger, and, taking advantage of the feebleness of Persia, has established herself in such a way that practically the opportunity for us is closed. We now, at Chitral, watch the approach from the Pamirs, and on that side, considering the nature of the region, do not seem to have much to fear.

Our various Colonies are most of them exposed to certain risks of their own. A few years ago Russia had designed an attack upon the Australian Colonies from her Pacific harbor of Vladivostock. It was intended that a fleet should sail upon the then open towns of Australia, harass them, and excact fines from them. The wisest advisers of the Colonies have of late years been anxious to restrain them from expending too much money upon defensive works. The defense of a great island like Australia must depend primarily upon the efficiency of the fleet, and secondly upon the careful organisation of the defensive forces on land. For a time the effect of the certainty of Russia's intention was to infuse such a vigor into the system of Australian defense that all danger of any such attempt seemed to have passed away. But there is always risk lest a democratic community shall go to sleep as soon as the immediate alarm has passed, and wake when it is too late.*

* I must draw attention to a volume on the *Federal Defense of Australasia*, by George Cathcart Craig (William Clowes and Son, 1897). It reaches me too late for notice here, but

There is a special form of attack which may be directed against those possessions of England beyond seas, which are, to say the least, less important as colonies than as outlying posts for the protection of the commerce of the mother-country, and of the Empire at large. This expression applies more particularly to our fortified coaling-stations. These have now so far advanced that it is to be hoped that before we are involved in war they will be completed, armed, and garrisoned so far as to fulfil the purpose for which they were intended. That purpose will be understood when I have explained the form of attack which a few years ago we had to dread. It was one directed expressly against the supplies of coal on which alike our fleet and our commerce depend for possibility of movement.

The fear which was felt by those who looked into the circumstances of any future naval warfare, was lest an enemy's cruiser might go into one of our unarmed coaling-stations, fill up her bunkers with coal, and, after setting fire to the remaining store in the place, proceed at her leisure to destroy commerce, having protected herself from pursuit by the destruction of the coal. She might then repeat the same operation at one coaling-station after another. Admiral Colomb has devoted much labor and skill to the demonstration of the fact that the elaborate fortification of harbors is a wasteful expenditure. He has shown that the question of supremacy at sea must necessarily be determined, not by land fortifications, but by naval superiority. These views have so far ruled in the construction of our coaling-station defenses, that no attempt has been made to make them strong enough to resist the attack of a formidable fleet. No one more fully than Admiral Colomb himself recognises the importance of those steps that we have actually taken to secure our supply of coal from the attack of ubiquitous cruisers.

The subject gained additional interest by the publication in Russia, some years since, of the little brochure, *Russia's Hope*, which was based upon this very idea, evidently stolen from some of our English authors, probably from my friend Colonel Home, at the time when, many years ago, he and others* were pressing for the defense of the coaling-stations. *Russia's Hope* would nowadays find that form of attack somewhat difficult. No protection that we have been able to devise, either in the past or the

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it admirably shows that there are Australians who are determined that our great Australasian colonies shall not sleep tranquilly in imaginary security, or foolishly dream that separation from Britain would make them safer or freer.

* Ultimately most vigorously of all Mr. W. H. Smith and Lord Carnorvon. See the excellent collection of Lord Carnarvon's speeches and letters on the subject, recently edited by Sir George Clarke, *The Defense of the Empire* (John Murray, 1897).

present, unless and until the whole of our enemy's fleets are securely locked up in their own harbors, can prevent an occasionally successful attack by a fleet escorting a land force against some isolated port. Ultimately, however, the fate of any of these will depend upon victory at sea. Beyond their local importance such attacks would have very little effect upon the general security of our commerce, except in so far as by the capture of one of our coaling-stations they broke some one of the great lines of these which have now been regularly laid out along the several courses of the great streams of our commerce at regulated intervals. Thus along the line to the Cape we have St. Helena and Sierra Leone, thence to India, Durban, Mauritius, Colombo, and our other lines are similarly laid out.

The capture of any one of these stations would, of course, interrupt for the time the regular coaling of our ships. That, therefore, is another of the forms of attack against which we have to be prepared.

It is unfortunately the case that there are various stations very necessary for the security of our trade where we are liable to attack from a different enemy, namely, malaria. It is always a question whether we ought not to provide against it, even at some sacrifice of our preparedness against a human foe. It is on this account that there have, till recently, been among our troops at home certain detachments which are noted as belonging to the proper garrison of certain unhealthy stations like Sierra Leone; for the moment of the outbreak of war these stations would have been left to the guardianship of the fleet. As soon as possible their proper garrisons were to have been sent out to them. As, however, the Admiralty might find it very difficult to secure due protection on the outbreak of war, it has recently been decided to have complete garrisons everywhere.

Similarly St. Lucia is an island of which the importance, from its excellent harbor and convenient situation, makes it most desirable to have as a defended coaling-station; yet it was considered too unhealthy for a permanent garrison to be maintained at its full strength. A large portion of its garrison was therefore to be sent from Barbados when the emergency arose. This, however, has now been changed, and, with such sanitary precautions as are possible, a garrison is now to be kept at St. Lucia.

So far as Canada is concerned, apart from any calamity so terrible as that of a war with our cousins in the States, there is always some danger during time of war of filibustering attempts being made from the United States against various points, and

especially against the long line of the Canadian Railway. Sir Charles Dilke, who has studied all such matters very carefully, attaches very great importance to these. Personally, I cannot say that any experience we have had of them in the past leaves that impression upon me. I could, if I pleased, which I certainly do not propose to do, name what I have always considered a weak point in our defensive arrangements on the American Continent. There is a point where a well-handled body of filibusters might achieve a rather startling success. But I do not think that, as long as the American Government proves as loyal as it has hitherto done in such matters, and as long as Fenian filibusters have so little power of keeping a secret, or of acting loyally towards one another, as they have hitherto shown, there is any serious danger for us of this kind. Canadian statesmen, who necessarily have had to look into the matter more closely than Sir Charles Dilke, have the most complete confidence in the security for all practical purposes of the great trans-continental line.

Though, in order to make myself intelligible, it has been necessary occasionally to allude, especially in regard to minor matters which need only brief treatment, to some points in the nature of the defense which we should have to adopt against certain possible forms of attack, my object in this chapter has been to consider the form of the various attacks which may be directed against the nation in different parts of the world. They may be enumerated thus :—

First of all, attacks upon our commerce by means of cruisers or fleets.

Secondly, an attempt to wrest from us the command of the sea, either permanently or temporarily.

Third, attacks upon open towns along our sea-board.

Fourth, attempted invasion either of this island or of Ireland by sea.

Fifth, if a Channel tunnel should ever be constructed, an attempt to seize, by surprise or otherwise, the means prepared for its destruction and the fortress which guards them.

Sixth, aggressive movements of Russia, preparatory to attack upon India itself.

Seventh, the actual attempt of Russia to invade India.

Eighth, attempts upon our Colonies other than coaling-stations.

Ninth, attempts upon our coaling-stations in the form of a cruiser attack upon the coal itself without any attempt to seize the station itself.

Tenth, attack by a serious force on a coaling-station with a view to occupy it either permanently or during the period of the war.

Eleventh, a mere predatory raid, such at that intended by Russia from Vladivostock, upon Australia.

Twelfth, filibustering raids from America upon Canada.

In addition to all of these forms of attack, which relate to the possible action of hostile European Powers, there is that which, in its practical effect in necessitating preparation and expenditure, exceeds them all—the danger, on the outlying frontiers of our Empire, of hostile incursions by neighboring tribes. It constantly happens that British people assume that whenever an Ashantee King or a Zanzibar Sultan defies the power of the British Empire the thing is so absurd that it must be the fault of our own people that he does not yield to reason. They do not realise how one of these chiefs, surrounded by flatterers as ignorant as himself, really believes all the titles that are bestowed on him, as King of Kings, Lord of the Universe, and the like, and has not the slightest means of estimating his own feebleness. Therefore, also, as war and not peace is for him and his people the natural condition, he habitually assumes an attitude of aggression, which is encouraged by the fact that every one who has to carry on negotiations for Britain—in any matter as to which the British people have not become exited and eager—wants before all things to avoid doing anything that can commit the nation to war. Constantly, in this way, a savage chief is thus tempted, by his own aggressiveness and our passivity, into just overstepping the line of what it is possible for us to tolerate. Then war comes, and half Britain thinks that it is all our fault, and attributes the cause to just the opposite of that to which a fair study of the facts leads.

All these possible forms of attack taken together, provided our Fleet be supreme upon the seas, do not represent a danger as serious as that which menaces Germany or France; but they do represent a necessary dispersion of force, dispersion of design in the nature of the defense, a vast number of independent local authorities in proportion to the number of men employed, and a consequent costliness which cannot but appear to compare unfavorably, no matter what schemes be devised for it, with the larger, the simpler, the more concentrated efforts of foreign countries. I am anxious to emphasise this broad aspect of the case. I wish to do so for this reason: I am convinced that it is

a pure and mere delusion, most costly, most mischievous in its effects, to attempt to persuade the British public that they can hold a world-wide empire, hold the commerce of the seas, do it at a *pro rata* proportion of their wealth, utterly insignificant as compared with that which any European Power expends on guarding their own little territory, and then allow themselves to be persuaded that all the time they are being bamboozled into a wasteful and useless expenditure. I say that it is on these broad lines that one may appeal to the common sense of any rational man to judge for himself.

Sir Charles Dilke once said that directly the attempt is made to go into detail it is extremely difficult for him, or any non-military statesman, seeking for particular items of wasteful expenditure, to answer the case made for them by soldiers. He speaks, in the first instance, as though it were the special interest of individual soldiers to defend extravagance. The fact is that the exact reverse is the case. If I, in any matter under my own responsibility, could detect some means by which the work could be done just a little cheaper than it actually is done, I should be an imbecile of the first water if I did not realise that in my own interest the first thing I had to do was to point this out. So deeply is this impressed on the minds of soldiers that I cannot remember ever to have seen a scheme of reform suggested by a soldier in which it was not proved, to the satisfaction of the writer at all events, that his proposals would lead to some, at least, trifling reduction of expenditure. The soldier in Britain who does not realise that the easiest way to secure his personal advancement is not to make £10,000 produce twice the effective work that it has done before, but to show that the same appearance of efficiency may be kept up for £9999:19:11¾, simply does not understand British finance. Soldiers may be great fools, but they are not quite so blind as all that.

To put money in his own pocket by securing positions of much greater importance than he at the time holds, this method of seeking out some apparent economy might be commended to any soldier in a sufficient position to practice it. It needs not to be so commended. It is thoroughly understood, and much practised.

There is an even better method, which has stood some men in excellent stead. It consists in proving, on excellent military grounds, that for the sake of efficiency it is highly necessary to carry out some petty military economy. By such methods the individual gains both in credit and pocket. It is the nation only that suffers.

The officer, therefore, who points out, on grounds that all men can understand, that it is not advisable to be perpetually recasting your whole system—because it can be shown that Germany or that France is able, for the same sum of money that we expend, to turn out an incomparably larger body of men than we do—ought not to have his argument suspected or rejected on *prima facie* grounds, because from his position he is necessarily suspected. The balance of presumption is altogether the other way.

It is not in this chapter that I can fully state the conclusions to which these remarks lead; but, in making out a statement of the variety of the attacks to which the world-wide extent of our empire on sea and land lays us open, it seems well to draw attention at once to the broad presumption to which they lead. It is in no wise my intention to contend that our system admits of no improvement, and that no waste occurs. For many reasons much waste occurs, and ought to be remedied; but the comparison often made with the armies of foreign Power is an altogether fallacious one, and tends not to economy, but to mischief.

HISTORY OF THE SEA-COAST FORTIFICATIONS OF THE UNITED STATES.

IV. OLD FORT MATANZAS.

Immediately in front of St. Augustine lies the northern end of Anastasia Island. This island stretching southward for seventeen miles terminates in a point called Matanzas—a name also given to the tide stream separating Anastasia from the mainland.

Few visitors to St. Augustine take the trouble to visit Matanzas, and yet it is well worthy of a visit. It was here that in 1565

Menendez, the founder of St. Augustine, slaughtered several hundred Huguenots wrecked on the coast near by. To this day human bones are sometimes exposed on the spot assigned by tradition as the scene of the slaughter. Only a few miles below Matanezas lies the original settlement of the so-called Minorcans, the ancestors of the present "native" population of St. Augustine.

Moreover, Matanzas was an important point in the attempt made by Governor Oglethorpe, of Georgia, to conquer the Spanish colony. This led the Spanish to fortify it, and the work they built forms today one of the most interesting ruins in our country.

It can be a question of only a few years, or of perhaps a storm of unusual severity, before this ruin will crumble completely to pieces. The writer accordingly, in 1886, spent several days in making complete measurements of the fort, with a view to securing some record before the final demolition took place.

Before, however, proceeding with the description that forms the subject of this paper, it may not be amiss to describe briefly the circumstances and reasons that led the Spanish Government to fortify Matanzas Point as it did, for at first sight the construction of a costly stone fort in a wilderness appears to be an absurdity.

The adjacent inlet is now but a shallow break in the chain of sandy islands skirting the east coast of Florida. According to tradition however, in the days of the Spanish dominion, the inlet was deep enough to admit the free passage of vessels, and communication with Havana was established through it. St. Augustine, we know, was hedged about by lines of vallation and circumvallation. It was protected not only by the great four-bastioned fort standing opposite the harbor entrance, but also by a long stockaded eartwork on its north, and by bastions on the west and south. But these last were of feeble profile. A determined enemy holding Matanzas River might turn, and so make useless the main line of defense stretching across the front of the city from Fort San Marco to the San Sebestian River. Hence, in any plan of defense, it was necessary to control the Matanzas, as well as to protect the front of the city. That these obvious conditions of military security should have escaped notice is not likely, and it is therefore more than probable that some defensive work always existed near the southern mouth of the Matanzas.

The local histories, it is true, state that this mouth was fortified only after Oglethorpe withdrew his blockading vessel theretrom. But this view, apart from its inherent improbability, is not confirmed by the statements of a quaint old geographer of the eighteenth century. He first describes St. Augustine itself: "The City runs along the shore at the bottom of a pleasant hill shaded with trees in the form of an oblong square being divided into four regular streets, which cut each other at right angles." And then he goes on to say: "About seven Leagues below the

Fort of *St. Augustine* are two Forts, the one on the north, and the other on the south side of a large lake. General Oglethorp destroyed the last, and took possession of the first, which is called Mauchicolis, surrounded with strong Palisadoes about eight foot high, with loopholes about seven foot high from the ground without; and within there is a Parapet, near three foot high, which makes the loopholes about breast high."*

The truth probably then is, that Matanzas was always protected by defensive works of some sort, and that after Oglethorpe's exploits, the Spanish Government resolved to make similar ones in the future, extremely difficult if not impossible, by constructing a work that would not only thoroughly defend the channel, but also successfully withstand a siege. Otherwise, it is hard to imagine why a fortification relatively so strong should have been built in what was then, and has been until lately, almost a wilderness.

In order to appreciate the advantages of the spot selected, it is necessary to understand that the Matanzas River, so-called, is really a narrow tide-water stream, lying, as has already been said, between Anastasia Island and the mainland, and communicating with the ocean at St. Augustine and Matanzas. As it nears the latter place the stream widens and its channel is divided into two by a series of low marshy islands, or rather islets; these passed, it reunites its branches and continues on its way about a mile to the ocean.† The southernmost of these islets forms the site of the fort. From this point its guns could be laid on both channels. It was safe from close attack by ship on account of the shallowness of the waters, and, for the same reason, it was out of range from the ocean. Being completely surrounded by water, it would be tolerably secure against surprise by either Indians or English. It is evident from these conditions that the fort was in all probability more than an adequate defense against any forces that might be brought against it, and would thus satisfy the purposes that led to its construction. Let us now briefly examine the work itself.

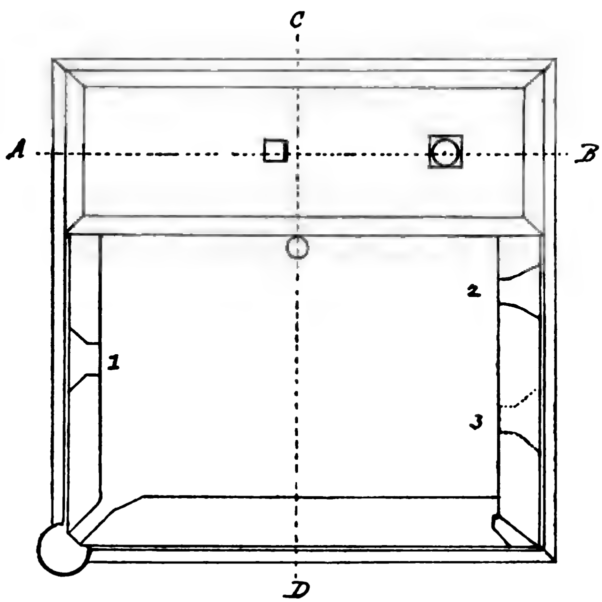
Standing as it does on the eastern shore of the islet mentioned, its general appearance is that of a broad, low platform, from the north side of which rises a narrow rectangular building. The material of which it is built is the coquina stone quarried on Anastasia, cut into regular blocks, and laid in regular courses.

* "A Complete System of Geography, by Emanuel Bowen, Geographer to his Majesty. For the use of all Gentlemen Mariners and others, who delight in History and Geography. London MDCCXLII." Vol. II, p. 365.

† For the map accompanying this paper I am indebted to Captain G. J. Fiebeger, Corps of Engineers, U. S. A., now professor of Engineering at the U. S. Military Academy.

The whole structure was once covered by white stucco, patches of which still stick on in defiance of the elements. It is now a ruin ; deep cracks split it from top to bottom ; the corners of the platform are slowly but surely crumbling away. Parapets and embrasures have lost their regularity of outline, while scrub cedars and other thick scrubs have sprouted and grown wherever their roots could lay hold.

FIGURE 1.



PLAN—Scale 1 : 169.7

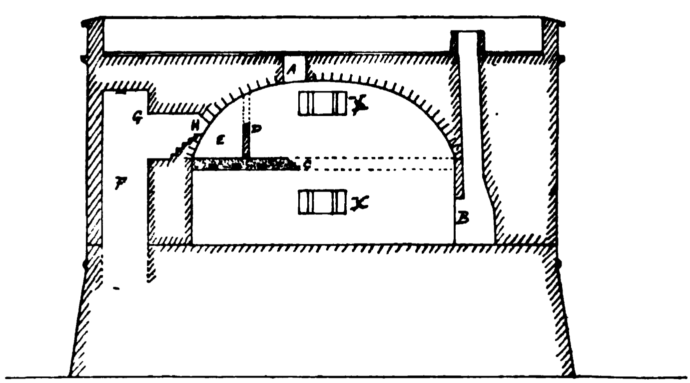
1, 2, 3, embrasures (3 almost completely crumbled out of recognition, and hence drawn dotted, its dimensions taken from 2).

The platform mentioned above consists of a block of solid masonry 49′ 6″ square at the base, and 10′ 5″ high. Its walls are not perpendicular, but slope in at the rate of about 1′ 6″ in 10′. The top of the slope is finished off by a cornice running completely around. From this cornice the walls and parapet rise perpendicularly. This block is laid in ten courses, and is pierced by neither window nor door, all access being by means of ladders —a disposition adding to the safety of the garrison and giving at the same time a certain degree of command to the guns. Time has simplified the entrance for us however, as a deep crack in the west front allows us to creep under the parapet into the work. On the north side, and running completely across the platform, stands the building already mentioned. This formed the barracks for the garrison, while the remaining space, 40′ by 25′ 7″, constituted

the gun platform, surrounded on three sides by a parapet, the barracks forming the fourth. This parapet is 4′ thick on the east, 4′ 9″ on the south and 3′ on the west. It is, or was, pierced by two embrasures on the sea-, and by one on the land-side, while over the remaining one the guns were mounted *en barbette*. For this reason, this portion of the parapet is somewhat lower than the remainder, being considerably less than 3′, as against 3′ 3″ on the east and west. Through the southwest corner a passage-way 21″ wide leads to a circular sentrybox, 3′ in diameter, all but the base of which has completely crumbled away. The floor of the platform was once smooth concrete. Two old iron guns still lie on it, their carriages having disappeared long ago. The great age of these guns is attested by the fact that the axis of the trunnions is not in the same plane with that of the bore. Half way between the end parapets, and immediately under the walls of the barracks, a circular hole 2′ in diameter opens into a cistern holding the water supply of the garrison. It is 13′ deep and 9′ 7″ in diameter to a height of 5′ 3″ from the bottom. This portion is built of hard brick. The neck of the cistern is 4′ 2″ long and joined to the part built of brick by a dome of coquina blocks cut and fitted with the utmost nicety to form a hemispherical surface.

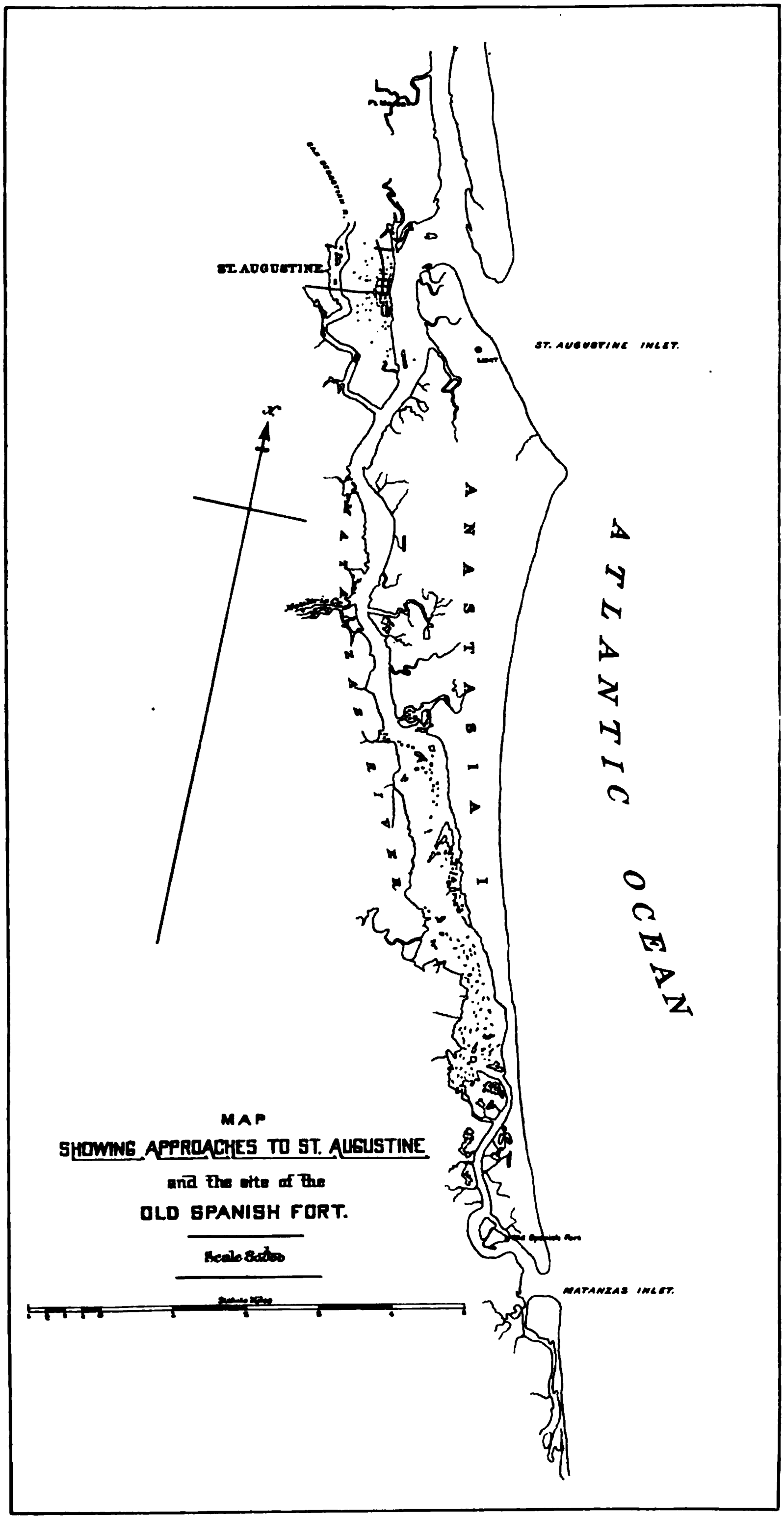
The most interesting part of the whole work, however, is that I have called the barracks. Externally these are 46′ 10″ long by 15′ 7″ wide and 21′ high. At a height of a little over 17′ a cornice surrounds the building. The walls are carried 3′ 3″ above this cornice so as to form a parapet to the flat roof, thus increasing

FIGURE 2.



SECTION ON A B—Scale 1 : 169.7.

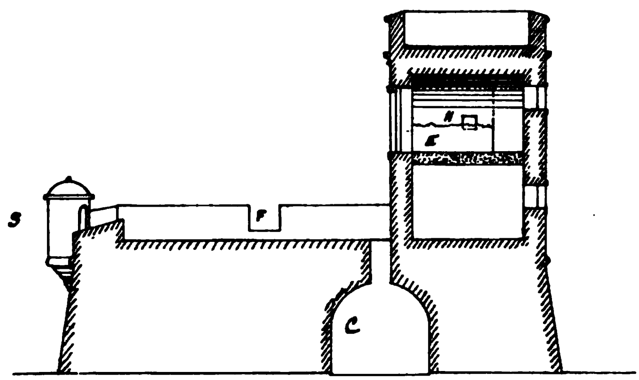
C, flooring of concrete. B, chimney. A, hole communicating with roof.
H, hole in face of arch communicating with well. F.
XX, windows.



ST. AUGUSTINE
ST. AUGUSTINE INLET
ATLANTIC OCEAN
ANASTASIA I
MATANZAS RIVER
Old Spanish Fort
MATANZAS INLET
MAP
SHOWING APPROACHES TO ST. AUGUSTINE
and the site of the
OLD SPANISH FORT.

the offensive power of the work. In this flat roof we may recognize a feature of Spanish architecture, applied in this case to military purposes. Entering through a low door-way, on the right of the cistern just described, we find ourselves in a large arched room, the distance from the crown of the arch to the floor being 15′ 7″, and between springing lines 27′. The surface of the arch is plastered over, and still shows traces of the bright blue color with which it was once washed. The interior arrangement of this room will be best understood by following the sections, Figs. 2 and 3. Near the highest point A is a rectangular hole 25″ by 26″, designed both to furnish ventilation and to give access to the roof. The eastern end is filled by a large stone fireplace,

FIGURE 3.



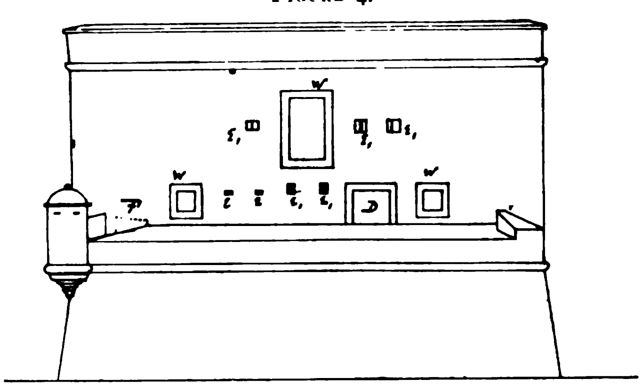
SECTION ON CD—Scale 1 : 169.7.

C, cistern. H, hole in face of arch communicating with well. E, partition wall—once running up to dotted line below A. The sentry-box S, is a restoration. A, hole communicating with roof. F, embrasure in west parapet.

B, now almost completely dismantled. The whole interior space was in former times divided into an upper and a lower room by a platform shown in section at C. Part of this platform still remains at the western end, and is of singular construction, being made of wooden beams, running across, between and over which rests a concrete floor over one foot thick. Its supporting ability depended on the thickness, and consequent rigidity, of the concrete. As lumber must have been plentiful and easily obtained, it is hard to see why so cumbrous and essentially weak a flooring should have been thought necessary. The western end of this room is cut off from the remainder by a stone wall D once running up to the arch, and now half torn down. A door-way through this leads into a kind of closet or cell E, from which a

hole 15″ square cut in the surface of the arch communicates by a flight of steps and a short passage with a circular well F, 4′ 3″ in diameter, and extending both up and down. This well is built in the thickness of the western wall and extends 2′ 3″ above the point G; its depth could not be determined, as it is partly filled with stones and rubbish. The use to which this well, as I have called it, could have been put, has given rise to much conjecture. In accordance with the custom prevailing in St. Augustine in similar cases, some consider it a prison cell connected with some dark mystery or evil design. But it is probably nothing worse than the powder magazine of the fort, an inference that may be fairly drawn from the care evidently taken to separate it from the remainder of the quarters. Into each of the rooms into which the arched space was divided, light and air were admitted by windows, there being a small one to each in the north wall. On the south the number is greater. Thus we find in the upper room one large window reaching to the floor, and flanked by loopholes for musketry. On the lower floor, in addition to the door, there are two windows, one at each end of the room, besides two loopholes. Nor must we forget to mention the queer little peepholes, 1″.5 by 3″, on the inside, through which, when all other openings were closed, the inlet and adjacent territory could be reconnoitred. Doors and windows both have plate-bands instead of lintels. The side walls of the building are 25″ thick;

FIGURE 4.



ELEVATION OF SOUTH FRONT.—Scale 1 : 169.7.

F, restoration showing how south parapet was probably connected with sentry-box. e_1e_1, loop-holes. e e, peep-holes (sentry-box restored). D, door. w, w, w, windows.

the end ones, forming the abutments of the arch, 10′. The space between the arch and the roof has been filled in solid, giving the arch an entirely unnecessary weight to support, and one that will

eventually cause the complete demolition of the building. It thus contains within itself the source of its own destruction. Even now a huge crack runs from top to bottom along the surfaces of weakness determined by putting the windo vs along the rise of the arch; while a second ever-widening crack almost completely separates the eastern abutment from the remainder of the building. The insecure foundations, unavoidable in so marshy a situation, are of course partly responsible for these fissures, but they should have warned the architect against loading the arch so severely.*

In examining this ruin, one cannot but be struck by the care displayed in the elaboration of details, some unimportant in themselves, and others made unnecessary in this particular fortification, both by its situation and the purpose it was intended to fulfill. As examples of this care, may be mentioned the cornices, the bevelled door- and window-jambs, the plate-bands and sills, all standing out in relief; the carved base of the sentry-box, and the mathematically accurate surfaces of the magazine and cistern. The great resemblance between these and corresponding details at Fort Marion inspires the belief, in the absence of other evidence, that the engineers who brought this last fortification to completion, designed and built the other. The date of erection of Fort Matanzas would thus be between 1740 and 1756.

In bringing this article to a close, we cannot help expressing a natural regret that our Government should have suffered the work here described to fall into its present ruinous condition. When the "change of flags" took place in 1821, it was probably in a fair state of preservation; it is now almost past saving. A little care and attention, a small outlay of money at the right time, would have preserved intact for years to come one of the most interesting monuments of our country—a memorial, to us, of the earnestness with which Spain strove to maintain her hold upon our land.

First Lieutenant C. de W. Willcox,
Second Artillery.

* The sheet-piling by which the foundations were strenghtened has not yet entirely disappeared.

BALLISTIC PROBLEMS IN INDIRECT AND CURVED FIRE.

It is generally admitted by writers on ballistics that the quadratic law of resistance holds for all velocities below 800 f. s.,* which includes nearly all firing with mortars and mountain howitzers and also the indirect fire of field and siege guns. The following formulas with the accompanying table have been prepared for these kinds of fire.

The fundamental equations employed in Siacci's method for direct fire are†

$$x = C\left\{S(u) - S(V)\right\} \tag{1}$$

$$y = x\tan\varphi - \frac{Cx}{2\cos^2\varphi}\left\{\frac{A(u)-A(V)}{S(u)-S(V)} - I(V)\right\} \tag{2}$$

$$\tan\theta = \tan\varphi - \frac{C}{2\cos^2\varphi}\left\{I(u)-I(V)\right\} \tag{3}$$

$$t = C\sec\varphi\left\{T(u)-T(V)\right\} \tag{4}$$

$$u = v\cos\theta\sec\varphi \tag{5}$$

$$C = \frac{\delta_1 w}{\delta\, c d^2} \tag{6}$$

Siacci considers these equations practically correct for all values of φ up to 20°‡.

For the entire horizontal range these equations become§

$$X = C\left\{S(u) - S(V)\right\} \tag{7}$$

$$\sin 2\varphi = C\left\{\frac{A(u)-A(V)}{S(u)-S(V)} - I(V)\right\} \tag{8}$$

$$\tan\omega = \frac{C}{2\cos^2\varphi}\left\{I(u) - \frac{A(u)-A(V)}{S(u)-S(V)}\right\} \tag{9}$$

$$T = C\sec\varphi\left\{T(u)-T(V)\right\} \tag{10}$$

* Siacci, *Balistique*, French edition, 1892, page 84. La Llave, *Balistica Abreviada*, 1893, page 77. Zaboudski, *Exterior Ballistics*, (in Russian) 1895, page 55. *The Bashforth Chronograph*, 1890, page 138.

† *Handbook.* Introduction and Appendix 1.

‡ *Rivista d'Artiglieria e Genio* for February, 1896.

§ For convenience of printing the letters u and v will refer to the far end of any arc under consideration. The conditions of the problem will always indicate what arc is meant.

$$u = v \cos \omega \sec \varphi \tag{11}$$

Mayevski's modification of these formulas for high angle fire, employing Didion's α, will be found in the Handbook, Appendix 2. It was intended at first to employ these modified equations in this paper for angles of departure lying between 15° and 30°, as being more accurate than any others known to the writer. But Siacci's paper "Nuova tavola della funzione β"† was received from the author in time to be used instead. By means of these functions or factors, applied to the ballistic coefficient, Siacci's formulas for direct fire are rendered equally applicable to high angle fire, with an immense saving of labor and no sacrifice of accuracy, as very searching tests have proven.

If, as first suggested by Braccialini,* we make the following substitutions, namely.

$$z = S(u) - S(V)$$

$$A = \frac{A(u) - A(V)}{S(u) - S(V)} - I(V)$$

$$B = I(u) - \frac{A(u) - A(V)}{S(u) - S(V)}$$

$$A' = A + B = I(u) - I(V)$$

$$B' = B/A$$

$$T' = T(u) - T(V),$$

equations (7), (8), (9) and (10) become, respectively,

$$X = Cz \tag{12}$$

$$\sin 2\varphi = AC \tag{13}$$

$$\tan \omega = \frac{BC}{2 \cos^2 \varphi} = B' \tan \varphi \tag{14}$$

$$T = C\,T' \sec \varphi \tag{15}$$

Equation (14) may also be written, when the ratio $\cos \varphi/\cos \omega$ is approximately unity,

$$\sin 2\,\omega = BC. \tag{16}$$

We have also introduced the following auxiliary functions into our table:

$$A'' = \frac{Bz}{A'} = \frac{y_0}{C \tan \varphi} \qquad C' = \frac{A}{z} = \frac{\sin 2\varphi}{X}\left(\frac{V}{800}\right)^2$$

$$C'' = \frac{A}{2\,T'} = \frac{V \sin \varphi}{800\,T} \qquad C''' = \frac{Az}{T'^2} = \frac{2X \tan \varphi}{T'^2}$$

† For a brief outline of the method of using this function see *Handbook*. Page 296.

* *Giornale d'Artiglieria e Genio*. Part 2, 1883.

Their uses will be shown in the proper problems.

For the quadratic law of resistance the ballistic functions $S(u)$, $A(u)$, $I(u)$, $T(u)$ take the following forms:*

$$S(u) = -\frac{\log_e u}{A_1} + Q_s$$

$$I(u) = \frac{g}{A_1 u^2} + Q_i$$

$$A(u) = \frac{g}{2 A_1^2 u^2} - \frac{Q_i}{A_1} \log_e u + Q_a$$

$$T(u) = \frac{1}{A_1 u} + Q_t$$

in which A_1 is an experimental constant determined by Mayevski from a discussion of the Krupp firings,† and whose value for English units is [5.6698914 — 10].

Q_s, Q_i, Q_a, Q_t are constants of integration. Substituting these values in the expressions for s, A, A', B and T' they become by easy reductions

$$s = \frac{1}{A_1} \log_e \left(\frac{V}{u}\right) \tag{17}$$

$$A = \frac{g}{2 A_1^2 s}\left(\frac{1}{u^2} - \frac{1}{V^2}\right) - \frac{g}{A_1 V^2} \tag{18}$$

$$B = \frac{g}{A_1 u^2} - \frac{g}{2 A_1^2 s}\left(\frac{1}{u^2} - \frac{1}{V^2}\right) \tag{19}$$

$$A' = \frac{g}{A_1}\left(\frac{1}{u^2} - \frac{1}{V^2}\right) \tag{20}$$

$$T' = \frac{1}{A_1}\left(\frac{1}{u} - \frac{1}{V}\right) \tag{21}$$

These equations may also be expressed exponentially as follows: Making

$$2 A_1 s = n$$

equation (17) gives

$$\frac{1}{u} = \frac{e^{\frac{1}{2}n}}{V}$$

and

$$\frac{1}{u^2} = \frac{e^n}{V^2}$$

and these values substituted in (18), (19), (20), (21) give

* *Handbook.* Pages 271-274.

† *Revue d'Artillerie*, April, 1883. Ingalls' *Exterior Ballistics.* Page 28. Zaboudski's *Exterior Ballistics* (in Russian). Page 55.

$$A = \frac{g}{A_1 V^2}\left(\frac{e^n - 1}{n} - 1\right) \tag{22}$$

$$B = \frac{g}{A_1 V^2}\left(e^n - \frac{e^n - 1}{n}\right) \tag{23}$$

$$A' = \frac{g}{A_1 V^2}\left(e^n - 1\right) \tag{24}$$

$$T' = \frac{1}{A_1 V}\left(e^{\frac{1}{2}n} - 1\right) \tag{25}$$

Also

$$u = \frac{V}{e^{\frac{1}{2}n}} \tag{26}$$

By division we have

$$\frac{B}{A} = B' = \frac{1 - (1 - n)e^n}{e^n - n - 1}$$

The factor B' is therefore independent of the muzzle velocity and depends only on the value of $z = X / C$. That is, for the same range and ballistic coefficient, the ratios of the tangents of the angles of departure and angles of fall are equal for all trajectories described by varying the muzzle velocity, within the limits of direct fire. The functions A'' and C''' are also independent of the muzzle velocity. Whence it follows that the maximum ordinates of all trajectories described as above are proportional to the tangents of the angles of departure (or angles of fall); and the squares of the times of flight are inversely proportional to the tangents of these angles, and therefore inversely proportional to the maximum ordinates.

If we have a table of the functions u, A, A', B, T', C', C'', for a particlar muzzle velocity and with z as argument, their values for any other muzzle velocity within the range of the quadratic law of resistance can be readily determined by the relations given in equations (22) to (26). Thus we have for a muzzle velocity V

$$u_v = \frac{V u}{800}$$

$$A_v = A\left(\frac{800}{V}\right)^2$$

$$A'_v = A'\left(\frac{800}{V}\right)^2$$

$$B_v = B\left(\frac{800}{V}\right)^2$$

$$T'_v = \frac{800\ T'}{V}$$

$$C'_v = C' \left(\frac{800}{V}\right)^2$$

$$C''_v = \frac{800\ C''}{V}$$

where the letters without subscripts refer to the accompanying table which was computed for a muzzle velocity of 800 f. s. By using these formulas the labor of double interpolation (that is, interpolation with reference to both z and V) is avoided, which is not only a saving of time but insures greater accuracy in the results.

If we consider the following seven quantities,—which may be regarded as the primary elements of a trajectory,—namely, C, V, X, φ, ω, v, T, it will be found that if any three of them be known the remaining four can be computed by the formulas already given. There may therefore be thirty-five cases involving only primary elements. These are not all of equal importance and some of the cases may be of very little value in gunnery; but for the sake of completeness they are all solved in the problems following and illustrated by numerical examples.

PROBLEM ONE.

Given: C, V, X. Required: φ, ω, v, T.

Solution.—Compute $z = X / C$ and with this take from the table u, A, $\log B'$, T'. Then by the preceding formulas

$$\sin 2\varphi = A\ C \left(\frac{800}{V}\right)^2$$

$$\tan \omega = B' \tan \varphi$$

$$T = \frac{800\ C\ T'}{V \cos \varphi}$$

$$v = \frac{V u \cos \varphi}{800 \cos \omega}$$

Example 1.—$C = 2$, $V = 700$ f. s., $X = 1000$ yards.

We first find $z = 1500$, and then from the table, $u = 745.9$, $A = .07902$, $\log B' = 0.02031$, $T' = 1.943$. Whence by the formulas, $\varphi = 5^\circ\ 57'\ 20''$, $\omega = 6^\circ\ 14'$, $v = 653$ f. s., $T = 4.465$ seconds.

For the same range and projectile A and C are constant in the above expression for $\sin 2\varphi$, and therefore for two values of φ and V, distinguished by subscripts, we have

$$\frac{\sin 2\varphi_1}{\sin 2\varphi_2} = \left(\frac{V_2}{V_1}\right)^2$$

That is, for the same range and ballistic coefficient, the sines of twice the angles of departure are inversely as the squares of the corresponding muzzle velocities.

Example 2.—In Ex. 1 suppose X and C to remain the same as there given while V becomes 750° f. s. What will be the value of φ?

We have

$$\sin 2\varphi = \left(\frac{700}{750}\right)^2 \sin 11^\circ\ 54'\ 40''$$

$$\therefore \quad \varphi = 5^\circ\ 10'\ 45''$$

Example 3.—Let X and C remain the same as before and φ be changed to 10. What will be the muzzle velocity?

Answer.

$$V = 700\left(\frac{\sin 11^\circ\ 54'\ 40''}{\sin 20^\circ}\right)^{\frac{1}{2}} = 543.78 \text{ f. s.}$$

It will be seen from these examples that if we have a range table for curved or indirect fire for a muzzle velocity V, we can, without recourse to any ballistic table, compute another range table having a different muzzle velocity.

PROBLEM TWO.

Given: C, V. φ. Required: X, ω, v, T.

Solution.—Compute

$$A = \frac{\sin 2\varphi}{C}\left(\frac{V}{800}\right)^2$$

and with this take from the table z, u, log B', T'. We then have

$$X = Cz$$

$$\tan\omega = B' \tan\varphi$$

$$v = \frac{Vu\cos\varphi}{800\cos\omega}$$

$$T = \frac{800\, C\, T'}{V\cos\varphi}$$

Example 1.—$C = \frac{1}{10}$, $V = 200$ f. s., $\varphi = 10^\circ$.

We find $A = .21376$, and from the table, $z = 3768.9$, $u = 670.7$, $\log B' = 0.05098$, $T' = 5.152$. Therefore $X = 376.9$ feet, $\omega = 11^\circ\ 13'$, $v = 168.35$ f. s., $T = 2.093$ sec.

Example 2.—The official range table* for the army magazine rifle gives $\varphi = 1° 40' 35''$ for a range of 1000 yards. Suppose we wish to practice with the sight set for this range but with a reduced charge giving a muzzle velocity of 400 f. s. How far off should the target be placed to simulate the 1000-yard range? Take $\log C = 9.46553$ which results from making $c = 1.197$.

We find $A = .050054$ and $z = 966.2$. Therefore $X = 282.23$ feet.

With the sight set for 500 yards, 1500 yards, or 2000 yards, we find in a similar manner, $X = 93.1$ ft., 571.2 ft. and 970.5 ft., respectively.

PROBLEM THREE.

Given: C, X, φ. Required: V, ω, v, T.

Solution.—Compute $z = X / C$ and with this take from the table u, A, $\log B'$, T'. Then

$$V = 800 \left(\frac{A\ C}{\sin 2\varphi}\right)^{\frac{1}{2}}$$

$$\tan \omega = B' \tan \varphi$$

$$v = \frac{V u \cos \varphi}{800 \cos \omega}$$

$$T = \frac{800\ C\ T'}{V \cos \varphi}$$

Example 1.—$C = 2$, $X = 1600$ yards, $\varphi = 10°$.

We find $z = 2400$, and from the table, $u = 715.1$, $A = .13016$, $\log B' = 0.03248$, $T' = 3.175$. Therefore $V = 697.95$, $\omega = 10° 46' 30''$, $v = 625.4$ f. s., $T = 7.391$ sec.

Example 2.—Suppose that in gallery practice with the army magazine rifle, $X = 50$ ft., and we wish to set the sight for a range of 1000 yds. What should be the muzzle velocity in order to hit the center of the target?

We have $\varphi = 1° 40' 35''$, $X = 50$ ft., $\log C = 9.46553$. Therefore $z = 171.18$ and $A = .00865$. Whence $V = 166.3$ f. s.

If we make $X = 100$ yds., we shall find that when the sight is set either for 500 yds., 1000 yds., 1500 yds., or 2000 yds., the following corresponding muzzle velocities will be required, namely, 726.0 f.s., 412.8 f.s., 285.6 f.s. and 214.3 f.s. Thus with suitable cartridges the 100-yard range (or any other convenient distance) can be used for the preliminary practice in sighting for all the ranges. It is believed that the process indicated in this example would give to the rather tiresome sighting drill, much

* G. O. 36, A. G. O., June 11. 1897, page 89.

of the excitement and interest attaching to actual target practice.

Example 3.—What initial velocity must be given to a golf ball to send it 150 yards before striking the ground (supposed to be horizontal), with an angle of rise (or departure) of 10°?

The weight of a *new* Silvertown golf ball is 41.877 grammes (a little less than $1\frac{1}{2}$ ounces), and its diameter is $1\frac{1}{16}$ inches.* The theoretical value of c is 1.391, which in the absence of experiment, we will adopt. This gives $\log C = 8.36749-10$.

We now have $z = X / C = 19307$,—which is below the limit of our table. To work the example it will be necessaay to compute A by Eq. (22), in which

$$\log \frac{g}{A_1 V^2} = 0.0312446,$$

and

$$n = [5.9709214-10]\, z.$$

We find $A = 1.95110$ and theh $V = 291.7$ f. s.

The following calculations have been made in a similar manner:

$X = 150$ yards.			$X = 200$ yards.		
φ	V	V In vacuo	φ	V	V In vacuo
10°	291.7 f.s.	205.7 f.s.	10°	387.1 f.s.	237.5 f.s.
20	215.8	150.0	20	288.2	173.3
30	187.8	129.3	30	252.0	149.3
40	181.6	121.2	40	247.2	140.0
45	183.6	120.3	45	252.1	138.9

For these comparatively low velocities the parabolic theory (motion *in vacuo*) would give approximately correct results for artillery projectiles, but not for a golf ball, as a comparison of these values of V shows.

They also illustrate the fact, already well known, that the angle of departure giving the maximum range in air is less than 45°.

It would seem from these, and from other similar calculations, that for a long drive, where the ball strikes on ground that precludes rolling, the angle of departure should be about 42°.

PROBLEM FOUR.

Given: C, φ, ω. Required: V, X, T, v.

Solution.—Compute $\log B' = \log \tan \omega - \log \tan \varphi$, and with this take from the table z, u, A, T'. We then have

* I am indebted to Lieutenant Richmond P. Davis for these data.

$$X = Cz$$

and V, T, v as in Prob. Three.

Example.—$C = \frac{1}{2}$, $\varphi = 8°$, $\omega = 10°$.

We find $\log B' = 0.09852$, $z = 7302.2$, $u = 568.54$, $A = 0.46692$, $T' = 10.880$; and by the formulas, $V = 736.24$ f. s., $X = 1217$ yds., $T = 5.967$ sec. and $v = 526.13$ f. s.

PROBLEM FIVE.

Given: V, X, φ. Required: C, T, ω, v.

Solution.—Compute

$$\log C' = \log \sin 2\varphi + 2 \log \left(\frac{V}{800}\right) - \log X,$$

and with this take from the table z, u, $\log B'$, T'. We then have

$$C = X / z$$

and T, ω, v as in Prob. One.

Example.—$V = 800$ f. s., $X = 2000$ yds., $\varphi = 10°$.

We find $\log C' = 5.7559 - 10$, $z = 3921.4$, $u = 665.94$, $\log B' = 0.05304$, $T' = 5.380$; and by the formulas $\log C = 0.18471$, $T = 8.359$ sec., $\omega = 11° 16'$, $v = 668.7$ f. s.

PROBLEM SIX.

Given: V, φ, T. Required: C, X, ω, v.

Solution.—Compute $\log C'' = \log \frac{V}{800} + \log \sin \varphi - \log T$, and with this take from the table z, u, A, $\log B'$, We then have

$$C = \frac{\sin 2\varphi}{A} \left(\frac{V}{800}\right)^2$$

and X, ω, v as in Prob. Two.

Example.—$V = 300$ f. s., $\varphi = 10°$, $T = 3$ seconds.

By computation $\log C'' = 8.33658$, and from the table $z = 8409$, $u = 539.9$, $A = 0.55904$, $\log B' = 0.11334$. With these values the formulas give $\log C = 8.93467 - 10$, $X = 723.5$ ft., $\omega = 12° 54'$, $v = 204.5$ f. s.

PROBLEM SEVEN.

Given: V, φ, ω. Required: C, X, T, v.

Solution.—Compute $\log B' = \log \tan \omega - \log \tan \varphi$, and with this take from the table z, u, A, T'. We then have

$$C = \frac{\sin 2\varphi}{A} \left(\frac{V}{800}\right)^2$$

and X, T, v as in Prob. Two.

Example.—$V = 700$ f. s., $\varphi = 10°$, $\omega = 12°$.

By computation $\log B' = 0.08115$, and from the table $z = 6008.2$, $u = 604.1$, $A = 0.36739$, $T' = 8.672$. With these tabular values the formulas give $\log C = 9.85294$, $X = 4282.3$ ft., $T = 7.173$ seconds, $v = 532.2$ f. s.

PROBLEM EIGHT.

Given: X, φ, T. Required: C, V, ω, v.

Solution.—Compute $\log C''' = \log(2X) + \log\tan\varphi - 2\log T$, and with this take from the table z, u, B, $\log B'$.
We then have

$$C = X / z$$

and V, ω, v as in Prob. Three.

Example 1.—The six shots fired from the 8-inch pneumatic torpedo gun at Fort Lafayette, September 20, 1887, at the Schooner *Silliman*, give the following data: Diameter of projectile 7.75 inches, weight of projectile (including charge of 55 lbs. of explosive-gelatine and dynamite), 137⅙ lbs.; mean range 5583.5 ft.; angle of departure 14° 53′ 20″; mean time of flight 10.63 seconds.*

Here $2X = 11167$ feet, $\varphi = 14°\ 53'\ 20''$, $T = 10.63$ seconds. Therefore $\log C''' = 1.41955$, and from the table, $z = 13925$, $u = 417$, $A = 1.13497$, $\log B' = 0.18621$. With these numbers the formulas give $\log C = 9.60311$, $V = 765.8$ f. s., $\omega = 22°\ 12'$, $v = 416.7$ f. s.

A standard projectile of the same diameter and weight would give $\log C = 0.35865$. Whence it follows that this projectile with its spiral wings for imparting rotation and its very unsteady flight, suffered a resistance more than 5½ times that of a service projectile.

These projectiles have been very much improved since the date of the above firing. From the report of the firing of a pneumatic torpedo gun at Shoeburyness, England, in the summer of 1890, made by B. C. Batcheller, S. B.,† with 8 and 10-inch subcaliber and 15-inch full caliber dummy projectiles, is taken the following data:

8-inch.	10-inch.
$w = 298$ lbs.	$w = 493$ lbs.
$d = 8.27$ in.	$d = 10.25$ in.
$\varphi = 15°\ 8'$	$\varphi = 15°\ 10'$
$X = 2931$ yds.	$X = 2298$ yds.
$T = 12.835$ sec.	$T = 11.2$ sec.

* This example will also be found in Ingalls' *Handbook*, page 117; in *Balistique Extérieure* by Vallier, page 93; and in *Problemas de Balistica* by La Llave, page 67.

† See *Journal U. S. Artillery*, whole No. 19.

With these data Prob. Eight readily gives for the 8-inch gun $V = 822$ f. s., $c = 2.834$; and for the 10-inch gun $V = 718.6$ f.s., $c = 3.403$.

It will be seen that the "laborious tentative process" by which this problem was originally solved is reduced by this method to a simple, direct and easy process of as many minutes as the former required hours.

PROBLEM NINE.

Given: X, φ, ω. Required: C, V, T, v.

Solution.—Compute $\log B' = \log \tan \omega - \log \tan \varphi$, with which take from the table z, u, A, T'. We then have

$$C = X / z$$

and V, T, v as in Prob. Three.

Example.—$X = 1000$ yds., $\varphi = 15°$, $\omega = 16°$.

We find $\log B' = 0.02944$, $z = 2175.6$, $u = 722.6$, $A = 0.11714$, $T' = 2.863$. Whence $\log C = 0.13954$, $V = 454.7$ f. s., $T = 7''.191$ and $v = 412.7$ f. s.

PROBLEM TEN.

Given: φ, T, ω. Required: C, V, X, v.

Solution.—Compute $\log B'$ as in Prob. Nine, with which take from the table z, u, A, T'. We then have

$$C = \frac{A}{2 \tan \varphi}\left(\frac{T}{T'}\right)^2$$

and V, X, v as in Probs. Two and Three.

Example.—$\varphi = 15°$, $T = 13$ sec., $\omega = 16°$.

We find $\log B'$, z, u, A and T' as in Prob. Nine. Whence $\log C = 0.65387$, $V = 821.8$ f. s., $X = 9805$ ft., and $v = 744.7$ f. s.

PROBLEM ELEVEN.

Given: φ, ω, v. Required: C, V, X, T.

Solution.—Compute $\log B'$ as in Prob. Nine, with which take from the table z, u, A, T'. We then have

$$V = \frac{800\, v \cos \omega}{u \cos \varphi}$$

and C, X, T as in Probs. Two and Six.

Example.—$\varphi = 5°$, $\omega = 7° 30'$, $v = 50$ f. s.

We find $\log B' = 0.17748$, $z = 13257.25$, $u = 430.3$, $A = 1.05330$, $T' = 22.959$. Whence $V = 93.4$ f. s., $\log C = 7.35166 - 10$, $X = 37.51$ ft., $T = 0.4436$ sec.

PROBLEM TWELVE.

Given: C, X, ω. Required: V, φ, v, T.

Solution.—Compute $z = X / C$ with which take from the table u, A log B', T'. Then compute

$$\tan \varphi = \frac{\tan \omega}{B'}$$

and V, v, T as in Probs. One and Two.

Example 1.—$C = 2$, $X = 1000$ yds., $\omega = 15°$.

We find $z = 1500$, $u = 745.9$, $A = .07902$, $\log B' = 0.02031$, and $T' = 1.943$. Therefore by the formulas, taken in order of computation, $\varphi = 14° \ 20' \ 40''$, $V = 459.0$ f. s., $v = 429.3$ f. s., $T = 6.991$ sec.

Example 2.—It is desired to open a searching fire upon the enemy (protected by cover from direct fire), with shrapnel from a battery of 3.2-inch field guns, at 2000 yards. The angle of descent should be 20° to be effective. What must be the muzzle velocity and angle of elevation—also striking velocity and time of flight?

Here $X = 6000$, $\omega = 20°$, and $\log C = 0.00816$. We find $z = 5888.3$, $A = .35859$, $\log B' = 0.07954$, $T' = 8.474$ and $u = 607.4$. Therefore by the formulas, $\varphi = 16° \ 51' \ 30''$, $V = 649.01$ f. s., $v = 501.9$ f. s., $T = 11.121$ sec.

If it were considered desirable to increase the angle of fall without changing the position of the battery, it could be done only by increasing the angle of elevation and decreasing the muzzle velocity. Suppose we increase the angle of departure to 20°, what should the muzzle velocity be?

$$\text{Answer.} \qquad V = 649.01 \left(\frac{\sin 33° \ 43'}{\sin 40°}\right)^{\frac{1}{2}} = 603.2 \text{ f. s.}$$

PROBLEM THIRTEEN.

Given: C, φ, T. Required: V, X, ω, v.

Solution.—We have the relation

$$\frac{C \tan \varphi}{T^2} = \frac{A}{T'^2} = \frac{C''}{T'}$$

by means of which C'' / T' (or rather its logarithm) is to be computed, and then z found from the table by inspection and trial. Then take from the table u, A, $\log B'$ by means of which the required elements can be computed as in Probs. Two and Three.

In preparing the accompanying table it would have been easy to compute an additional column for C'' / T', by means of which

the value of z in any particular case could be taken out directly. But the importance of the problem does not warrant such an extension of the table. The value of z can be found with very little labor by inspection and trial.* The same remark applies to fourteen of the thirty-five problems involving only primary elements.

Example.—$C = 3$, $\varphi = 5°$, $T = 3$ sec.

We find $\log C'' - \log T' = 8.46483 - 10$, which is satisfied when $z = 546.18$. Therefore $u = 779.9$, $A = 0.02792$, $\log B' = 0.00740$. Whence $V = 555.6$ f. s., $X = 1638.54$ ft., $\omega = 5° \ 5'$, $v = 541.7$.

PROBLEM FOURTEEN

Given: C, T, ω. Required: V, X, φ, v.

Solution.—Compute

$$\frac{B}{T'^2} = \frac{2\ C \tan \omega}{T^2}$$

with which find z from the table by inspection and trial. Then take out u, A, $\log B'$ and compute

$$\tan \varphi = \frac{\tan \omega}{B'}$$

and the other required elements as in Probs. Two and Three.

Example.—$C = 2$, $T = 10$ sec., $\omega = 20°$.

We find $\log \dfrac{B}{T'^2} = 8.16313$, and by trial, this is satisfied when $z = 2289$. Therefore $u = 718.8$, $A = 0.12369$, $\log B' = 0.03098$. Whence $X = 4578$ ft., $\varphi = 18° \ 43'$, $V = 510.4$ f. s., $v = 462.2$ f.s.

PROBLEM FIFTEEN.

Given: C, ω, v. Required: V, X, φ, T.

Solution.—Compute

$$B\,u^2 = \frac{v^2 \sin 2\omega}{C}$$

with which find z from the table by inspection and trial, and then take out u, $\log B'$, T'. We then compute the required elements as in Probs. Two, Three and Fourteen.

Example 1.—$C = 1$, $\omega = 15°$, $v = 200$ f.s. We have

$$B\,u^2 = 20{,}000$$

from which we find $z = 635.2$, and then $u = 776.6$, $\log B' = 0.00861$, $T' = 0.806$. Whence $V = 206.0$ f. s., $X = 635.2$ ft., $\varphi = 14° \ 43'$, $T = 3.236$ sec.

* See *Handbook*, pages 62-64 for an illustration of the method by "trial and error".

Example 2.—"An escarp had to be breached at the siege of Strasburg by a gun, equivalent to an 8-inch howitzer of 70 cwt., on the same level. From information received from a spy, the ditch was known to be about 50 feet wide; in consequence of which the necessary angle of descent was calculated to be 14°. The howitzer was using common shell and delay-action fuze, and the Engineers required that the striking velocity was not to fall short of 600 f. s.

Find the least requisite distance of the howitzer from the escarp, the necessary muzzle velocity and angle of departure."*

Here $w = 180$, $d = 8$, $c = \frac{10}{9}$, $\log C = 0.40333$, $v = 600$ f.s., $\omega = 14°$. Our trial equation is

$$\log B u^2 = 4.82458$$

from which we find $z = 2221.7$, and then $u = 721.1$, $\log B' = 0.03007$, $T' = 2.927$. Therefore $V = 663.1$ f. s., $X = 1875$ yds., $\varphi = 13° 6'$, $T = 9.177$ sec.

The muzzle velocity in this problem may be computed approximately by means of the inclination and time functions, and the velocity at the summit of the trajectory (v_0). We have approximately, and assuming that $\cos \varphi = \cos \omega$,

$$I(v_0) = I(v) - \frac{\sin 2\omega}{C}$$

by means of which v_0 can be computed. Then upon the hypothesis that the time from the origin to the summit is equal to the time from the summit to the point of fall, we have†

$$T(V) = 2\,T(v_0) - T(v)$$

which gives V. We then have

$$u = \frac{800\,v}{V}$$

by means of which z, $\log B'$ and T' can be taken from the table as before.

PROBLEM SIXTEEN.

Given: X, T, ω. Required: C, V, φ, v.

Solution.—Compute

$$\frac{B z}{T'^2} = \frac{2 X \tan \omega}{T^2}$$

and with this find z from the table by inspection and trial, and

* *Text Book of Gunnery.* London. 1897. Page 269.

† *Handbook.* Pages 61-62.

take out u, A, log B'. The required elements can then be computed as in Probs. Three, Five and Fourteen.

Example.—$X = 1000$ yds., $T = 7$ sec., $\omega = 16°$.

We find $z = 5531.3$, $u = 617.7$, $A = 0.33278$, log $B' = 0.07474$.

Whence log $C = 9.73429$, $V = 503.2$ f.s., $\varphi = 13° \ 34' \ 20''$, $v = 391.0$ f. s.

PROBLEM SEVENTEEN.

Given: X, ω, v. Required: C, V, φ, T.

Solution.—Compute

$$\frac{B u^2}{z} = \frac{v^2 \sin 2\omega}{X},$$

and with this find z from the table by inspection and trial, and take out u, A, log B', T'. The required elements are then computed as in Probs. Three, Five and Fourteen.

Example.—$X = 2000$ yds., $\omega = 15°$, $v = 600$ f. s.

We find $z = 2270$, $u = 719.4$, $A = .12259$, log $B' = 0.03072$, $T' = 2.994$. Therefore log $C = 0.42212$, $\varphi = 14° \ 1'$, $V = 664.2$ f. s., $T = 9.823$ sec.

PROBLEM EIGHTEEN.

Given: T, ω, v. Required: C, V, X, φ.

Solution.—Compute

$$\frac{B u}{T'} = \frac{2 v \sin \omega}{T}$$

and with this find z from the table by inspection and trial. Then take out u, A, log B' and compute the required elements as in Probs. Two, Six, Eleven and Fourteen.

Example.—$T = 2.2$ sec., $\omega = 20°$, $v = 100$ f. s.

We find from the table $z = 4788$, $u = 639.6$, $A = .28093$, log $B' = 0.06474$. Therefore log $C = 8.68293$, $V = 123.18$ f. s., $X = 230.7$ ft., $\varphi = 17° \ 24' \ 35''$.

PROBLEM NINETEEN.

Given: C, V, ω. Required: X, φ, T, v.

Solution.—For a first approximation assume

$$\cos \varphi = \cos \omega,$$

and compute

$$B = \frac{\sin 2\omega}{C}\left(\frac{V}{800}\right)^2$$

with which take from the table z, u, A, T', and then compute X, φ, T, v as in Probs. One and Two. Repeat if necessary making

$$B = \frac{2 \cos^2 \varphi \tan \omega}{C} \left(\frac{V}{800} \right)^2$$

which is its true value.

Example.—$C = 3$, $V = 650$, $\omega = 5°$.

We find by computation $B = .0382$ and then from the table $z = 727.3$, $u = 773.3$, $A = .03739$, $T' = 0.925$. Whence $X = 2181.9$ ft., $\varphi = 4° 53'$, $T = 3.428$ sec., $v = 628.3$ f. s. These results are practically correct; but when φ and ω differ considerably from each other it will be necessary to repeat where great accuracy is desired.

PROBLEM TWENTY.

Given: C, V, v. Required: X, φ, T, ω.

Solution.—Assuming $\cos \varphi = \cos \omega$, compute

$$u = \frac{800\, v}{V}$$

with which take from the table z, A, $\log B'$, T', and then compute the required elements as in Probs. One and Two. If considered necessary u can be re-computed by the accurate formula

$$u = \frac{800\, v \cos \omega}{V \cos \varphi}$$

Example.—$C = 1$, $V = 800$, $v = 732$.

We find $u = 732$ and from the table $z = 1900$, $A = .10139$, $\log B' = 0.02572$, $T' = 2.484$. Therefore $X = 1900$ ft., $\varphi = 2° 54' 30''$, $\omega = 3° 5'$, $T = 2.487$ sec.—which need no correction.

PROBLEM TWENTY-ONE.

Given: C, X, v. Required: V, φ, T, ω.

Solution.—Compute $z = X / C$, with which take from the table u, A, $\log B'$, T'. Then assuming for a first approximation, $\cos \varphi = \cos \omega$, compute

$$V = \frac{800\, v}{u}$$

and then φ, T, ω as in Probs. One and Two. Repeat if necessary, making

$$V = \frac{800\, v \cos \omega}{u \cos \varphi}$$

which is its true value.

Example.—$C = 1$, $X = 3000$, $v = 600$.

We have $z = 3000$, and from the table $u = 695.3$, $A = 0.16590$, $\log B' = 0.04059$, $T' = 4.026$. Whence $V = 690.4$, $\varphi = 6° 26'$, $T = 4.662$ sec., $\omega = 7° 3' 30''$.

PROBLEM TWENTY-TWO.

Given: V, X, v. Required: C, φ, T, ω.

Solution.—Assuming $\cos\varphi = \cos\omega$, compute

$$u = \frac{800\,v}{V}$$

with which take from the table z, A, $\log B'$, T'. Then compute

$$C = \frac{X}{z}$$

and the other elements as in Probs. One and Two. Repeat if necessary making

$$u = \frac{800\,v\cos\omega}{V\cos\varphi}.$$

Example.—$V = 800$, $X = 4000$ ft., $v = 692$.

We have $u = 692$, whence $z = 3100$, $A = .17199$, $\log B' = 0.04194$, $T' = 4.170$. Therefore $\log C = 0.11070$, $\varphi = 6° 24' 40''$, $T = 5.415$ sec., $\omega = 7° 3' 20''$.

PROBLEM TWENTY-THREE.

Given: V, φ, v. Required: C, X, T, ω.

Solution.—Compute u as in Prob. Twenty-Two, and take z, A, $\log B'$ and T' from the table. Then compute the required elements by the formulas given in Probs. Two and Six. Repeat if necessary, as in Prob. Twenty-Two.

Example.—$V = 200$, $\varphi = 2°$, $v = 116.25$.

We have $u = 465$, whence $z = 11600$, $A = .86592$, $\log B' = 0.15570$, $T' = 19.152$. Therefore $\log C = 7.70198-10$, $X = 58.4$ ft., $T = 0.388$ sec., $\omega = 2° 51' 40''$.

PROBLEM TWENTY-FOUR.

Given: V, T, v. Required: C, X, φ, ω.

Solution.—Compute u as in Prob. Twenty-Two, and take z, A, $\log B'$, T' from the table. We then have

$$\sin\varphi = \frac{A}{2}\frac{T}{T'}\left(\frac{800}{V}\right)^2$$

and C, X, ω as in Probs. Two and Six. Repeat with $\cos\varphi$ and $\cos\omega$ if necessary.

Example.—$V = 800$, $T = 2$, $v = 732$.

We find $z = 1900$, $u = 732$, $A = .10139$, $\log B' = 0.02572$. Whence $\log C = 9.90554-10$, $X = 1528.6$ ft., $\varphi = 2° 20' 22''$, $\omega = 2° 28' 55''$.

PROBLEM TWENTY-FIVE.

Given: V, ω, v. Required: C, X, φ, T.

Solution.—Compute u as in Prob. Twenty-Two and take z, A, log B', T' from the table. The required quantities are then computed as in Probs. Two, Six, Fourteen. Repeat if necessary, as in Prob. Twenty-Two.

Example.—$V = 800$, $\omega = 20°$, $v = 692$.

We find for a first approximation, $z = 3100$, $u = 692.0$, log $B' = 0.04194$. Therefore $\varphi = 18° \; 17' \; 10''$. Now re-computing u, introducing cos φ and cos ω we get $u = 684.86$, $z = 3323$, log $B' = 0.04496$. Whence $\varphi = 18° \; 10' \; 10''$. Repeating the operation once more we have finally $u = 684.4$, $z = 3337.5$, $A = .18262$, log $B' = 0.04516$, $T' = 4.515$. Therefore log $C = 0.50160$, $X = 10593$ ft., $\varphi = 18° \; 9' \; 40''$, $T = 15.082$ sec.

PROBLEM TWENTY-SIX.

Given: C, φ, v. Required: V, X, T, ω.

Solution.—Assuming cos φ = cos ω, compute

$$Au^2 = \frac{v^2 \sin 2\varphi}{C}$$

and with this find z from the table by inspection and trial. Then take out u, A, log B', T' and compute the required elements as in Probs. Two and Three. If necessary repeat making

$$Au^2 = \frac{2\, v \tan \varphi \cos^2 \omega}{C}$$

which is the true value.

Example.—$C = 5$, $\varphi = 2°$, $v = 500$.

We find $z = 109.14$, $u = 796$, $A = .00550$, log $B' = 0.00147$, $T' = 0.137$. Therefore $V = 502.3$, $X = 545.7$ ft., $\omega = 2° \; 00' \; 24''$, $T = 0.685$ sec.

PROBLEM TWENTY-SEVEN.

Given: V, T, ω. Required: C, X, φ, v.

Solution.—Assuming cos φ = cos ω, compute

$$\frac{B}{T'} = \frac{2\, V \sin \omega}{800\, T}$$

with which find z from the table by inspection and trial, and take out u, A, log B'. The required elements are then computed as in Probs. One, Four, Six and Twelve. Repeat if necessary making

$$\frac{B}{T'} = \frac{2\, V \cos \varphi \tan \omega}{800\, T}$$

Example.—$V = 800$ f. s., $T = 4$ sec., $\omega = 5°$.

We find $\log \frac{B}{T'} = 8.63927$ which is satisfied when $z = 2046$. Therefore $u = 727.0$, $A = .10970$, $\log B' = 0.02769$, and $\log C = 0.17208$, $X = 3041$ ft., $\varphi = 4° \ 41' \ 30''$, $v = 727$ f. s. These require no correction.

PROBLEM TWENTY-EIGHT.

Given: X, φ, v. Required: C, V, T, ω.

Solution.—Assuming $\cos \varphi = \cos \omega$, compute

$$\frac{A\,u^2}{z} = \frac{v^2 \sin 2\varphi}{X}$$

with which find z from the table by inspection and trial, and take out u, A, $\log B'$, T'. The required elements are then computed as in Probs. Three and Five. Repeat if necessary by making

$$\frac{A\,u^2}{z} = \frac{2\,v^2 \tan \varphi \cos^2 \omega}{X}$$

Example.—$X = 1600$ ft., $\varphi = 5°$, $v = 540$ f. s.

We find $\log \frac{A\,u^2}{z} = 1.50034$, which is satisfied when $z = 253.4$. Therefore $u = 790.6$, $A = .01283$, $\log B' = 0.00343$, $T' = 0.319$. Whence $\log C = 0.80031$, $V = 546.4$ f. s., $T = 3.727$ sec., $\omega = 5° \ 2' \ 20''$.

PROBLEM TWENTY-NINE.

Given: φ, T, v. Required: C, V, X, ω.

Solution.—Assuming $\cos \varphi = \cos \omega$, compute

$$\frac{Au}{T'} = \frac{2\,v \sin \varphi}{T}$$

with which find z from the table by inspection and trial, and take out u, A, $\log B$, T'. Compute the required elements as in Probs Three, Four, Ten, Twelve. Repeat if necessary by making

$$\frac{Au}{T'} = \frac{2\,v \tan \varphi \cos \omega}{T}$$

Example.—$\varphi = 5°$, $T = 4$ sec., $v = 550$ f. s.

We find $\log \frac{Au}{T'} = 1.37963$, which is satisfied when $z = 7794.3$. Therefore $u = 555.6$, $A = .50705$, $\log B' = 0.10511$, $T' = 11.755$. Whence $\log C = 9.52575$, $V = 791.9$ f. s., $X = 2615$ ft., $\omega = 6° \ 21' \ 30''$. These are close approximations.

PROBLEM THIRTY.

Given: V, X, ω. Required: C, φ, T, v.

Solution.—Assuming $\cos\varphi = \cos\omega$, compute

$$\frac{B}{z} = \frac{\sin 2\omega}{X}\left(\frac{V}{800}\right)^2$$

with which find z from the table by inspection and trial, and take out u, A, $\log B'$, T'. We then compute the required elements as in Probs. One and Five. Repeat if necessary making

$$\frac{B}{z} = \frac{2\cos^2\varphi\tan\omega}{X}\left(\frac{V}{800}\right)^2$$

Example.—$V = 550$ f. s., $X = 1600$ f. s., $\omega = 5°$.

We find $\log\dfrac{B}{z} = 5.71009 - 10$, which is satisfied when $z = 296.5$. Therefore $u = 789.0$, $A = .01503$, $\log B' = 0.00401$, $T' = 0.374$. Whence $\log C = 0.73210$, $\varphi = 4° 57' 15''$, $T = 2.947$ sec., $v = 542.4$ f. s.

PROBLEM THIRTY-ONE.

Given: C, V, T. Required: X, φ, ω, v.

Solution.—For a first approximation assume

$$\cos\varphi = 1,$$

and compute

$$T' = \frac{TV}{800\,C}$$

with which take A from the table, and compute

$$\sin 2\varphi = AC\left(\frac{800}{V}\right)^2$$

With this value of φ compute

$$T' = \frac{TV\cos\varphi}{800\,C}$$

which is the complete expression for T', and take from the table z, u, A, $\log B'$. The required elements can then be computed as Probs. One and Two.

Example.—$C = 3$, $V = 800$, $T = 10$.

We first find $T' = 3\frac{1}{3}$ and $\varphi = 12° 7'$. Next $T' = 3.259$, $z = 2460$, $u = 713.0$, $A = 0.13368$, $\log B' = 0.03329$. Whence $X = 7380$ ft., $\varphi = 11° 49'$, $\omega = 12° 44'$, $v = 715.5$ f. s. It might be necessary for extreme accuracy to again repeat the calculation using the last value of φ.

PROBLEM THIRTY-TWO.

Given: C, X, T. Required: V, φ, ω, v.

Solution.—Compute $z = X / C$ and with this take from the table u, A, $\log B'$, T'. We then have

$$V = \frac{800\, C\, T' \cos\varphi}{T}$$

and the required elements as in Prob. One. It will be necessary to assume

$$\cos\varphi = 1,$$

which is accurate enough when φ is less than $5°$. For greater values of φ we must repeat the operation as many times as is necessary.

Example.—$C = 3$, $X = 2000$ yds., $T = 10$ sec.

We find $z = 2000$, $u = 728.6$, $A = 0.10707$, $\log B' = 0.02707$, $T' = 2.621$. Omitting $\cos\varphi$ we find $V = 629.04$ and $\varphi = 15°\ 39'$. Introducing $\cos\varphi$ and repeating the operation four times we finally obtain $V = 600.3$ f. s. and $\varphi = 17°\ 23'$ which are their true values. The other elements are $\omega = 18°\ 26'$, $v = 550.0$ f. s.

PROBLEM THIRTY-THREE.

Given: V, X, T. Required: C, φ, ω, v.

Solution.—Compute

$$\frac{T'}{z} = \frac{T\, V \cos\varphi}{800\, X}$$

assuming for a first approximation $\cos\varphi = 1$. Find z from the table by inspection and trial and take out u, A, $\log B'$. The required elements can then be computed as in Probs. One and Five. Repeat the operation with $\cos\varphi$ as many times as may be necessary.

Example.—$V = 550$ f. s., $X = 1600$ ft., $T = 3$ sec.

Answer. $\log C = 0.15104$, $\varphi = 5°\ 4'\ 35''$, $\omega = 5°\ 15'\ 30''$ $v = 522$ f. s.

PROBLEM THIRTY-FOUR.

Given: C, T, v. Required: V, X, φ, ω.

Solution.—Compute

$$T'u = \frac{T\, v \cos\omega}{C}$$

assuming for a first approximation

$$\cos\varphi = \cos\omega = 1.$$

Find z from the table by inspection and trial and take out u, A, log B'. We then have approximately

$$V = \frac{800\,v}{u}$$

$$X = Cz$$

$$\sin 2\varphi = A\,C\left(\frac{800}{V}\right)^2$$

$$\tan\omega = B'\tan\varphi.$$

Repeat as often as may be necessary, supplying the factors $\cos\varphi$ and $\cos\omega$ in the expression for V, and $\cos\omega$ in the expression for $T'\,u$.

Example.—log $C = 9.52575 - 10$, $T = 4$ sec., $v = 550$ f.s.

Answer.—$V = 792$ f.s., $X = 2615$ ft., $\varphi = 5°$, $\omega = 6°\ 21'\ 30''$.

PROBLEM THIRTY-FIVE.

Given: X, T, v. Required: C, V, φ, ω.

Solution.—Compute

$$\frac{T'\,u}{z} = \frac{T\,v\cos\omega}{X}$$

and proceed as in Prob. 34.

Example.—$X = 1200$ yds., $T = 6$ sec., $v = 525$ f.s.

We have, by two approximations, log $C = 9.73863$, $V = 710$ f.s., $\varphi = 8°\ 16'$, $\omega = 10°\ 6'$.

PROBLEM THIRTY-SIX.

Given: Any three of the seven elements of a trajectory to compute the coordinates of its summit (x_0, y_0), and the summit velocity (v_0).

Solution.—If C, V, A and φ are not already known, compute them by means of the given data as previously explained and illustrated. Find the value of A in the A' column and take out the corresponding values of z, u, A'', designating the first two, since they refer to to the summit, by z_0, u_0. We then have*

$$x_0 = Cz_0$$

$$y_0 = A''\,C\tan\varphi$$

$$v_0 = \frac{V u_0\cos\varphi}{800}.$$

Example.—Compute x_0, y_0, v for the the trajectory of Prob. 12. Here $C = 2$, $V = 459.0$ f.s.. $A = .07902$, $\varphi = 14°\ 20'\ 40''$. Making $A' = .07902$ we find $z_0 = 758.5$, $u_0 = 772.2$, $A'' = 383.8$.

* *Handbook*, Problem XIII.

Therefore $x_0 = 1517.0$ ft., $y_0 = 196.29$ ft., $v_0 = 429.2$ f. s. As v_0 differs from v by only a tenth of a foot (Prob. 12), it follows that in this trajectory the point of minimum velocity is near the point of fall.

PROBLEM THIRTY-SEVEN.

Given: y_0, C, φ. Required: The remaining elements of the trajectory.

Solution.—Compute

$$A'' = \frac{y_0}{C \tan \varphi},$$

with which take A' from the table and find its value in the A column. With this latter take out z, u, log B', T', and compute the elements as in Problems 3 and 4.

Example.—$C = 1$, $\varphi = 10°$, $y_0 = 50$ ft.

We find $A'' = 283.56$, $A' = A = .05796$, $z = 1113.7$. Therefore $X = 1113.7$ ft., $V = 329.3$ f.s.

As the muzzle velocity is quite small in this example, it will be interesting to see how the above range compares with that given by the parabolic theory. By this theory we have

$$X = 4 y_0 \cot \varphi.$$

Giving to y_0 and φ the values in the above example we find $X = 1134.3$ ft.

PROBLEM THIRTY-EIGHT.

Given: The elements of a trajectory. Required: The value of y for any given value of x.

Solution.—We have*

$$y = \frac{\tan \varphi}{A} (A - a) x.$$

In this equation A is either taken from the table with the argument

$$z = X/C,$$

or it may be computed by the formula

$$A = \frac{\sin 2 \varphi}{C} \left(\frac{V}{800} \right)^2.$$

The quantity a varies with the abscissa x, and is taken from the same column as A with the argument x / C.

Example 1.—$V = 850$ f.s., $\varphi = 15°$, $C = 5$. Compute the maximum ordinate, and the ordinate when

* *Handbook*, Problem XV.

$$x = X - 100 \text{ ft.}$$

1. We find $A = 0.11289$ and $z = 2101.74$. Therefore $X = 10508.7$ ft. and $x = 10408.7$. The general expression for y is readily found to be

$$y = [0.37539] \left\{ 0.11289 - a \right\} x.$$

2. For $x = 10408.7$ we find $z = 2081.74$, corresponding to which in the A column we have $a = 0.11175$, and then $y = 28.2$ ft. For the maximum ordinate we find $A'' = 515.8$; whence

$$y_0 = 5 \times 515.8 \tan 15° = 691.04 \text{ ft.}$$

Example 2.—Suppose that in Ex. 2 of Prob. 15, there was a ridge between the position selected for the gun and the escarp to be breached, whose crest was 80 ft. above the level of the gun and 100 yards from the escarp. Would the shot clear the crest?

Here from Prob. 15 and the new data, $X = 1875$ yards, $\varphi = 13° 6'$, $z = 2221.7$, $A = 0.11979$, $x = 5325$ ft. and $\log C = 0.40333$, to find y. The new value of z from which to get a from the table is $5325/C = 2103.7$, from which $a = .11300$. We next find $\log (\tan \varphi/A)$ to be 0.29295. The general expression for y for this trajectory is therefore

$$y = [0.29295] \left\{ 0.11979 - a \right\} x$$

and supplying the values of a and x for this particular case, we find

$$y = 70.98 \text{ ft.}$$

The projectile would then strike the side of the ridge 9 ft. below its crest. To carry the projectile over the ridge and not diminish the striking velocity the gun must be placed further from the escarp, supposing the ground to be level. Suppose we assume the gun to be placed 300 yards further from the escarp, would the projectile then clear the ridge? In this case we have $X = 2175$ yds. $= 6525$ ft., $\log C = 0.40323$ and $v = 600$ f.s. to find the other elements of the trajectory by Prob. 21 and y as above. In computing V by Prob. 21 we will employ the values of φ and a already given or found, since although they will both be increased by the new data, still the *ratio* of their cosines will be sensibly unaltered. We find $z = 2577.8$, $u = 709.1$, $A = .14061$, $\log B' = 0.03488$. Whence $V = 674.25$ f. s., $\varphi = 15° 2' 5''$, $\omega = 16° 14'$. To compute y we have $x = 6225$ ft., $x/C = 2459.3$ and $a = .13363$ by means of which we find $y = 83.00$ ft. The projectile would then clear the ridge by three feet. We may now determine the

distance of the gun from the escarp so that the projectile would just graze the ridge as follows: For a range of 5625 ft. the tratory passes 9.02 ft. below the crest of the ridge; and for a range of 6525 ft. the trajectory is too high by 3 ft. We therefore have the proportion

$$12 : 900 :: 3 : 225,$$

whence the required range is 6525—225 = 6300 ft. With this value of X we find $z = 2488.9$, and from the table $u = 712.2$, $A = .13537$, $\log B' = 0.03368$. Whence $V = 670$ f.s., $\varphi = 14° 37' 15''$, $\omega = 15° 44' 30''$. The value of y computed for these last data is 80.24 ft. The problem is therefore completely solved.

Example 3.—$V = 200$ m.s., $\varphi = 30°$, $d = 24$ cm., $w = 144$ kg.* The complete expression for C when Siacci's factor β is employed is

$$C = f\frac{\delta_1}{\delta}\frac{w}{cd^2\beta}$$

In this example f, δ_1/δ and c are each taken as unity and $\beta = 1.06$.† We will give the work entire to show the procedure when metric units are employed. It will be observed that these units increase the labor but slightly.

$$\begin{aligned} \text{Const. } \log &= 1.15298 \\ \log w &= 2.15836 \\ \text{a.c. } \log d^2 &= 7.23958 \\ \text{a.c. } \log \beta &= 9.97469 \\ \hline \log C &= 0.52561 \end{aligned}$$

$$\begin{aligned} \log 200 &= 2.30103 \\ \text{Const. } \log &= 0.51599 \\ \text{a.c. } \log 800 &= 7.09691 \\ \hline \log V/800 &= 9.91393 \\ & \quad\quad\; 2 \\ \hline 2 \log V/800 &= 9.82786 \\ \log \sin 2\varphi &= 9.93753 \\ \text{a.c. } \log C &= 9.47439 \\ \hline \log A &= 9.23978 \\ A &= .17369 \end{aligned}$$

$$z = 3100 + \frac{17000}{613} = 3127.7$$

$$u = 695.3 - .277 \times 3.3 = 694.4$$

$$\log B' = 0.04194 + .277 \times 135 = 0.04231.$$

$$A'' = 820 + \frac{1.9 \times 52}{117} = 828.4$$

* Vallier's *Balistique Extérieure*. Paris, 1895. Page 101.

† See Table VI of *Handbook*. This is Siacci's *first* table of these factors and differs slightly from his *new* table, but principally in the longer ranges.

$$\begin{aligned}
\log\tan\varphi &= 9.76144\\
\log B' &= 0.04231\\
\hline
\log\tan\omega &= 9.80375\\
\omega &= 32^\circ\ 28'\ 30''
\end{aligned}
\qquad
\begin{aligned}
\log z &= 3.49523\\
\log C &= 0.52561\\
\text{Const. }\log &= 9.48401\\
\hline
\log X &= 3.50485\\
X &= 3198 \text{ m.}
\end{aligned}$$

$$\begin{aligned}
\log u &= 2.84161\\
\log\cos\varphi &= 9.93753\\
\log\sec\omega &= 0.07385\\
\log V/800 &= 9.91393\\
\text{Const. }\log &= 9.48401\\
\hline
\log v &= 2.25093\\
v &= 178.2 \text{ m.s.}
\end{aligned}
\qquad
\begin{aligned}
\log C &= 0.52561\\
\log A'' &= 2.91824\\
\log\tan\varphi &= 9.76144\\
\text{Const. }\log &= 9.48401\\
\hline
\log y_0 &= 2.68930\\
y_0 &= 489 \text{ m.}
\end{aligned}$$

Example 4.—The same projectile as Ex. 3, and $X = 4000$ m., $\varphi = 35^\circ$. For this range and elevation $\beta = 1.08$, which gives $\log C = 0.51750$.

Answers.—$V = 217.8$ m.s., $\omega = 38^\circ\ 24'\ 20''$, $T = 24.646$ sec., $v = 189.9$ m.s., $y_0 = 744.6$ m.

These results, as well as those of Ex. 3, agree almost exactly with those obtained in an entirely different manner by Vallier.

The "general ballistic tables for mortar firing" published in the *U. S. Artillery Journal*, Vol. V, page 52, also give the same results practically as the above.

Example 5.—$V = 204.1$ m.s., $d = 21$ cm., $w = 91$ kg., $\varphi = 45^\circ$. Determine the range, For this we have $\beta = 1.17$ and $c = 1\frac{1}{9}$, whence $\log C = 0.35736$.

Answer.—$X = 11811$ ft. The mean of five shots fired at Meppen with the above conditions was 11848 ft. See Krupp's *Expériences di tir*, No. 31, January 19, 1892.

Example 6—$V = 220$ m.s., $X = 3000$ m., $\varphi = 22^\circ\ 6'$. Compute C, ω, v, T, x_0, y_0.* We will give the entire work as a further illustration of how to use metric data with English tables. The additional labor involved is not worth mentioning.

The elements of the trajectory are computed by Prob. 5.

$$\begin{aligned}
\log\sin 2\varphi &= 9.84334\\
2\log V/800 &= 8.87866\\
\text{a.c. }\log X &= 6.52287\\
\text{Const. }\log &= 0.51599\\
\hline
\log C' &= 5.76086
\end{aligned}
\qquad
\begin{aligned}
\log V &= 2.34242\\
\log 800 &= 2.90309\\
\hline
& 9.43933\\
& 2\\
\hline
& 8.87866
\end{aligned}$$

$\therefore\quad z = 4200 + \frac{960}{14} = 4268.6$, and by interpolation with z as

* Siacci, *Balistique*, page 87.

argument, $u = 655.2$, $A = .24614$, $\log B' = 0.05773$, $T' = 5.905$. With $A' = A$ as argument we find $A'' = 1140$ and $z_0 = 2204.4$.

$$\begin{aligned} \log X &= 3.47712 \\ \text{a.c. } \log z &= 6.36971 \\ \text{Const. } \log &= 0.51599 \\ \hline \log C &= 0.36282 \end{aligned}$$

$$\begin{aligned} \log \tan \varphi &= 9.60859 \\ \log B' &= 0.05773 \\ \hline \log \tan \omega &= 9.66632 \\ \omega &= 24^\circ\ 53' \end{aligned}$$

$$\begin{aligned} \log 800 &= 2.90309 \\ \log C &= 0.36282 \\ \log T' &= 0.77122 \\ \text{a. c. } \log V &= 7.65758 \\ \log \sec \varphi &= 0.03314 \\ \text{Const. } \log &= 9.48401 \\ \hline \log T &= 1.21186 \\ T &= 16.288 \text{ sec.} \end{aligned}$$

$$\begin{aligned} \log V &= 2.34242 \\ \log u &= 2.81637 \\ \log \cos \varphi &= 9.96686 \\ \text{a.c. } \log 800 &= 7.09691 \\ \log \sec \omega &= 0.04231 \\ \hline \log v &= 2.26487 \\ v &= 184.0 \text{ m.s.} \end{aligned}$$

$$\begin{aligned} \log C &= 0.36282 \\ \log A'' &= 3.05690 \\ \log \tan \varphi &= 9.60859 \\ \text{Const. } \log &= 9.48401 \\ \hline \log y_0 &= 2.51232 \\ y_0 &= 325.3 \text{ m.} \end{aligned}$$

$$\begin{aligned} \log z_0 &= 3.34329 \\ \log C &= 0.36282 \\ \text{Const. } \log &= 9.48401 \\ \hline \log x_0 &= 3.19012 \\ x_0 &= 1549.2 \text{ m.} \end{aligned}$$

These results are practically the same as those deduced by Siacci's table.

PROBLEM THIRTY-NINE.

Given: The elements of a trajectory. Required: The value of θ for any given value of x.

Solution.—We have*

$$\tan \theta = \frac{\tan \varphi}{A}\left(A - A'\right)$$

In this equation A is either taken from the table with the argument $z = X / C$, or, if X is not given, it may be computed by the equation

$$A = \frac{\sin 2\varphi}{C}\left(\frac{V}{800}\right)^2$$

The quantity A' varies with the abscissa x and is taken from the A' column with the argument x/C.

Example 1.—$C = 1$, $V = 800$ f.s., $\varphi = 5°$. Compute the inclination of the trajectory when $x = 2000$ ft.

By Prob. Two we have $A = \sin 2\varphi = .17365$, and from the table, $A' = .2211$. Therefore

* *Handbook*, pages 9 and 111.

$$\tan\theta = \frac{\tan 5^\circ}{.17365}(.17365 - .2211)$$

$$\therefore \quad \theta = -1^\circ\ 22'\ 10''.$$

Example 2.—Determine the inclination of the trajectory in both branches when $y = \frac{1}{2} y_0$, with the data of Ex. 1.

We first compute, by Prob. Thirty-six, $y_0 = 71.8$ ft. We have next to compute x' in the ascending branch and x'' in the descending branch, for each of which $y = \frac{1}{2} y_0 = 35.9$, by a modification of Prob. Thirty-eight. We have, by substituting Cz for x,

$$y = \frac{\tan\varphi}{A}(A - a)\ Cz$$

whence

$$(A - a)z = \frac{Ay}{C\tan\varphi}$$

from which to determine z and a by inspection and trial.

In this example we have

$$\log[(.17365 - a)z] = 1.85281$$

In the ascending branch this equation is satisfied when $z = 479.5$; and in the descending branch when $z = 2786.4$. The corresponding values of A' are .0492 and .3200, and the inclinations 3° 35′ and −4° 13′. The abscissas x' and x'' have in this case, since the ballistic coefficient in unity, the same values as z above.

PROBLEM FORTY.

To determine the elements of a trajectory for a given projectile which shall pass through two given points.

Solution.—Let x, y and x', y' be the two given points, and $\varepsilon, \varepsilon'$ their angular elevations (or depressions) above (or below) the level of the gun. Then

$$\tan\varepsilon = y/x \text{ and } \tan\varepsilon' = y'/x'.$$

From Prob. Thirty-eight we have

$$\tan\varepsilon = \frac{\tan\varphi}{A}(A - a)$$

and

$$\tan\varepsilon' = \frac{\tan\varphi}{A}(A - a')$$

In these equations a is to be taken from the "A" column with the argument $z = x/C$, and a' with the argument $z' = x'/C$. Solving for A and $\tan\varphi$ we find

$$A = \frac{a' \tan \varepsilon - a \tan \varepsilon'}{\tan \varepsilon - \tan \varepsilon'}$$

and

$$\tan \varphi = \frac{A \tan \varepsilon}{A - a} = \frac{A \tan \varepsilon'}{A - a'}$$

The elements of the trajectory can now be computed as in Probs. Three and Four. It will be observed that all the formulas of this problem are independent of the muzzle velocity.

Example.—$C = 2$, $x = 1800$ ft., $y = 50$ ft., $x' = 2200$ ft., $y' = -10$ ft.

We find $a = .04652$ and $a' = .05722$, whence

$$A = \frac{220 \times .05722 + 36 \times .04652}{220 + 36} = .055715$$

$$\tan \varphi = \frac{.05571}{36 \times .00919} \quad \therefore \varphi = 9^\circ\, 33'\, 30''$$

Next by the formula

$$V = 800 \left(\frac{AC}{\sin 2\varphi}\right)^{\frac{1}{2}}$$

we find

$$V = 466.6 \text{ f. s.}$$

All the other elements can now be computed by methods already explained and illustrated.

By the parabolic theory the expressions for $\tan \varphi$ and V are

$$\tan \varphi = \frac{x' \tan \varepsilon - x \tan \varepsilon'}{x' - x}$$

and

$$V^2 = \frac{g}{2 \cos^2 \varphi} \cdot \frac{x' - x}{\tan \varepsilon - \tan \varepsilon'}$$

These formulas give with the data of this example

$$\varphi = 9^\circ\, 49'\, 40''$$
$$V = 452.7 \text{ f.s.}$$

PROBLEM FORTY-ONE.

To determine the elements of a trajectory for a given projectile which shall pass through a given point, with a given inclination.

Solution.—We have as in Prob. Forty,

$$\tan \varepsilon = \frac{\tan \varphi}{A} (A - a)$$

and from Prob. Thirty-nine,

$$\tan \theta = \frac{\tan \varphi}{A} (A - A')$$

Z	u	D	A	D	D	$\log C''$	D	$\log C'''$	D
						—10			
100	796.3	3.7	0.00504	50	13	8.30352	34	1.5066	6
200	792.6	3.7	.01011	51	14	8.30386	34	1.5060	7
300	788.9	3.7	.01521	51	13	8.30420	35	1.5053	7
400	785.2	3.6	.02035	51	14	8.30455	34	1.5046	7
500	781.6	3.7	.02552	52	14	8.30489	35	1.5039	6
600	777.9	3.6	.03072	52	13	8.30524	35	1.5033	7
700	774.3	3.6	.03595	52	14	8.30559	35	1.5026	7
800	770.7	3.6	.04122	53	13	8.30594	35	1.5019	6
900	767.1	3.6	.04652	53	14	8.30629	35	1.5013	7
1000	763.5	3.6	.05186	53	14	8.30664	35	1.5006	7
1100	759.9	3.5	.05722	54	14	8.30699	36	1.4999	6
1200	756.4	3.5	.06262	54	13	8.30735	35	1.4993	7
1300	752.9	3.5	.06805	54	14	8.30770	36	1.4986	7
1400	749.4	3.5	.07352	55	14	8.30806	36	1.4979	6
1500	745.9	3.5	.07902	55	14	8.30842	36	1.4972	6
1600	742.4	3.5	.08456	55	14	8.30878	36	1.4966	7
1700	738.9	3.4	.09013	56	13	8.30914	36	1.4959	7
1800	735.5	3.5	.09574	56	14	8.30950	36	1.4952	6
1900	732.0	3.4	.10139	56	14	8.30986	37	1.4946	7
2000	728.6	3.4	.10707	57	14	8.31023	37	1.4939	7
2100	725.2	3.4	.11279	57	14	8.31060	37	1.4932	6
2200	721.8	3.4	.11854	57	14	8.31097	37	1.4926	7
2300	718.4	3.3	.12433	58	14	8.31134	37	1.4919	6
2400	715.1	3.3	.13016	58	14	8.31171	37	1.4913	7
2500	711.8	3.4	.13602	59	15	8.31208	37	1.4906	7
2600	708.4	3.3	.14192	59	14	8.31245	38	1.4899	6
2700	705.1	3.3	.14786	59	14	8.31283	37	1.4893	7
2800	701.8	3.2	.15383	60	14	8.31320	38	1.4886	6
2900	698.6	3.3	.15985	60	14	8.31358	38	1.4880	7
3000	695.3	3.3	.16590	60	14	8.31396	38	1.4873	7
3100	692.0	3.2	.17199	61	15	8.31434	38	1.4866	6
3200	688.8	3.2	.17812	61	14	8.31472	38	1.4860	7
3300	685.6	3.2	.18429	62	14	8.31510	39	1.4853	6
3400	682.4	3.2	.19050	62	14	8.31549	38	1.4847	7
3500	679.2	3.2	.19675	62	15	8.31587	39	1.4840	7
3600	676.0	3.1	.20304	63	14	8.31626	39	1.4833	6
3700	672.9	3.2	.20937	63	14	8.31665	39	1.4827	7
3800	669.7	3.1	.21574	64	15	8.31704	39	1.4820	6
3900	666.6	3.1	.22215	64	14	8.31743	39	1.4814	7
4000	663.5	3.1	.22860	64	14	8.31782	39	1.4807	7
4100	660.4	3.1	.23509	65	15	8.31821	40	1.4800	6
4200	657.3	3.0	.24163	65	14	8.31861	40	1.4794	7
4300	654.3	3.1	.24821	66	15	8.31901	40	1.4787	6
4400	651.2	3.0	.25483	66	14	8.31941	40	1.4781	7
4500	648.2	3.0	.26149	67	15	8.31981	40	1.4774	6

Z	u	D	A	D	log C''	D	log C'''	D
					—10			
4600	645.2	3.0	0.26820	14	8.32021	40	1.4768	7
4700	642.2	3.0	.27495	15	8.32061	41	1.4761	6
4800	639.2	3.0	.28174	14	8.32102	40	1.4755	7
4900	636.2	3.0	.28858	15	8.32142	41	1.4748	6
5000	633.2	2.9	.29546	15	8.32183	41	1.4742	7
5100	630.3	3.0	.30238	15	8.32224	41	1.4735	6
5200	627.3	2.9	.30935	14	8.32265	41	1.4729	7
5300	624.4	2.9	.31637	15	8.32306	41	1.4722	6
5400	621.5	2.9	.32343	15	8.32347	41	1.4716	7
5500	618.6	2.9	.33054	15	8.32388	42	1.4709	6
5600	615.7	2.9	.33770	15	8.32430	41	1.4703	7
5700	612.8	2.8	.34490	14	8.32471	42	1.4696	6
5800	610.0	2.9	.35215	15	8.32513	42	1.4690	7
5900	607.1	2.8	.35944	15	8.32555	42	1.4683	6
6000	604.3	2.8	.36678	15	8.32597	42	1.4677	6
6100	601.5	2.8	.37417	15	8.32639	42	1.4671	7
6200	598.7	2.8	.38161	15	8.32681	43	1.4664	6
6300	595.9	2.8	.38910	15	8.32724	42	1.4658	6
6400	593.1	2.8	.39664	14	8.32766	43	1.4652	7
6500	590.3	2.7	.40422	15	8.32809	43	1.4645	6
6600	587.6	2.7	.41186	15	8.32852	43	1.4639	6
6700	584.9	2 8	.41955	15	8.32895	44	1.4633	6
6800	582.1	2 7	.42728	15	8.32939	43	1.4627	7
6900	579.4	2.7	.43507	15	8.32982	44	1.4620	6
7000	576.7	2.7	.44291	15	8.33026	44	1.4614	6
7100	574.0	2.7	.45080	15	8.33070	44	1.4608	7
7200	571.3	2.7	.45875	16	8.33114	44	1.4601	6
7300	568.6	2.6	.46674	15	8.33158	45	1.4595	6
7400	566.0	2.7	.47479	15	8.33203	44	1.4589	7
7500	563.3	2.6	.48289	15	8.33247	45	1.4582	6
7600	560.7	2.6	.49105	15	8.33292	45	1.4576	6
7700	558.1	2.6	.49926	16	8.33337	45	1.4570	6
7800	555.5	2.6	.50752	15	8.33382	45	1.4564	7
7900	552.9	2.6	.51584	15	8.33427	45	1.4557	6
8000	550.3	2.6	.52421	15	8.33472	45	1.4551	6
8100	547.7	2.5	,53264	16	8.33517	45	1.4545	7
8200	545.2	2.6	.54112	15	8.33562	46	1.4538	6
8300	542.6	2.5	.54966	16	8.33608	46	1.4532	6
8400	540.1	2.5	.55826	15	8.33654	45	1.4526	7
8500	537.6	2.5	.56691	15	8.33699	46	1.4519	6
8600	535 1	2.5	.57562	16	8 33745	46	1.4513	6
8700	532.6	2.5	.58439	15	8.33791	47	1.4507	6
8800	530.1	2.4	.59322	16	8.33838	46	1.4501	7
8900	527.7	2.5	.60211	15	8.33884	47	1.4494	6
9000	525.2	2.5	.61105	16	8.33931	47	1 4488	6

Z	u	D	D	$\log C''$	D	$\log C'''$	D
				—10			
9100	522.7	2.4	15	8.33978	46	1.4482	6
9200	520.3	2.4	16	8.34024	47	1.4476	6
9300	517.9	2.4	16	8.34071	48	1.4470	6
9400	515.5	2.4	15	8.34119	47	1.4464	6
9500	513.1	2.4	16	8.34166	48	1.4458	7
9600	510.7	2.4	16	8.34214	47	1.4451	6
9700	508.3	2.4	16	8.34261	48	1.4445	6
9800	505.9	2.4	15	8.34309	49	1.4439	6
9900	503.5	2.3	16	8.34358	49	1.4433	6
10000	501.2	2.3	16	8.34406	49	1.4427	6
10100	498.9	2.4	16	8.34455	49	1.4421	6
10200	496.5	2.3	16	8.34504	49	1.4415	6
10300	494.2	2.3	16	8.34553	49	1.4409	6
10400	491.9	2.3	16	8.34602	49	1.4403	7
10500	489.6	2.3	15	8.34651	50	1.4396	6
10600	487.3	2.2	16	8.34701	49	1.4390	6
10700	485.1	2.3	16	8.34750	50	1.4384	6
10800	482.8	2.3	16	8.34800	50	1.4378	6
10900	480.5	2.2	16	8.34850	50	1.4372	6
11000	478.3	2.2	16	8.34900	50	1.4366	6
11100	476.1	2.3	16	8.34950	50	1.4360	6
11200	473.8	2.2	16	8.35000	50	1.4354	6
11300	471.6	2.2	16	8.35050	51	1.4348	6
11400	469.4	2.2	16	8.35101	51	1.4342	6
11500	467.2	2.2	17	8.35152	50	1.4336	6
11600	465.0	2.2	16	8.35202	51	1.4330	6
11700	462.8	2.1	16	8.35253	51	1.4324	6
11800	460.7	2.2	16	8.35304	52	1.4318	6
11900	458.5	2.1	16	8.35356	51	1.4312	6
12000	456.4	2.1	16	8.35407	51	1.4306	6
12100	454.3	2.1	17	8.35458	52	1.4300	6
12200	452.2	2.1	16	8.35510	52	1.4294	6
12300	450.1	2.1	16	8.35562	52	1.4288	6
12400	448.0	2.1	16	8.35614	52	1.4282	6
12500	445.9	2.1	17	8.35666	52	1.4276	5
12600	443.8	2.1	16	8.35718	53	1.4271	6
12700	441.7	2.0	16	8.35771	52	1.4265	6
12800	439.7	2.1	17	8.35823	53	1.4259	6
12900	437.6	2.0	16	8.35876	53	1.4253	6
13000	435.6	2.0	17	8.35929	53	1.4247	6
13100	433.6	2.1	16	8.35982	53	1.4241	6
13200	431.5	2.1	17	8.36035	54	1.4235	6
13300	429.4	2.0	16	8.36089	53	1.4229	6
13400	427.4	2.0	17	8.36142	54	1.4223	6
13500	425.4	1.9	17	8.36196	54	1.4217	5
13600	423.5	2.0	16	8.36250	54	1.4212	6
13700	421.5	2.0	17	8.36304	54	1.4206	6
13800	419.5	2.0	16	8.36358	54	1.4200	6
13900	417.5	1.9	17	8.36412	55	1.4194	6
14000	415.6	1.9	17	8.36467	55	1.4188	5

Therefore

$$A = \frac{A' \tan \varepsilon - a \tan \theta}{\tan \varepsilon - \tan \theta}$$

and

$$\tan \varphi = \frac{A \tan \varepsilon}{A - a} = \frac{A \tan \theta}{A - A'}$$

A' and a are to be taken from the table with the argument $z = x / C$.

The corresponding expressions by the parabolic theory are

$$\tan \varphi = 2 \tan \varepsilon - \tan \theta$$

and

$$V^2 = \frac{g\, x \cos \varepsilon}{2 \cos \varphi \sin (\varphi - \varepsilon)}$$

Example.—$C = 2$, $x = 400$ ft., $y = 40$ ft., $\theta = 5°$.

We have $z = 200$, $a = .01011$, $A' = .0203$, $\tan \varepsilon = 01$. Whence $A = .09156$, $z = 1725.5$, $X = 3451$ ft., $V = 726.5$ f.s., $\varphi = 6° \, 24' \, 50''$.

These last two are very important problems in indirect fire.

JAMES M. INGALLS,
Major, First Artillery.

PROFESSIONAL NOTES.

ORGANIZATION.

Japan's Army and Navy.

There may and there may not be war in the far East. But whether there is or not, it is well to make a note of the fact that Japan is swiftly coming to the fore as one of the great military and naval Powers not only of the Eastern Hemisphere, but of all the world. She is to-day building more ships and better ships than any other Power, with the single exception of Great Britain, and at the present rate of progress will in a few years rank as the second naval power of the world. This sounds startling, when we remember that at the time of Trafalgar the Land of the Rising Sun was of no more account in the world than the Fiji Islands, and that down to a generation ago it was reckoned a semi-barbarous country. The idea that it will, within the lives of men who remember its "opening," become the rival of the Power that opened it, and of France and Germany, seems like a fairy tale. Yet it is the sober truth.

Japan is now building in England four first-class battle-ships, one first-class cruiser of twenty-three knots, two gigantic armored cruisers of twenty knots and eight torpedo-boat destroyers of thirty knots. In Germany she is building one armored cruiser and eight torpedo-boats, and in France one armored cruiser and four torpedo-boats. In this country she has ordered two cruisers of twenty-three knots, and at home she is building three cruisers, one armored cruiser and three torpedo-boats. At the end of the Chinese war she had forty-three ships, besides torpedo-boats. She will by 1906 have added thereto six battle-ships of about 15,000 tons each, six armored cruisers of 9,200 tons each, five other cruisers, three torpedo gunboats, eleven torpedo-boat destroyers and ninety torpedo-boats. All these will, of course, be of the latest and most approved pattern. An example of their quality is furnished by one of the warships now approaching completion in England, which will be the largest and most powerful battle-ship ever built for any navy in the world, surpassing even the leviathans of Great Britain. It will be 438 feet long and 76 feet wide, with a displacement of 15,240 tons. It will be armored from stem to stern with nine inches of Harvey steel, and its barbettes will have fourteen inches of such armor. Its batteries will include four 12-inch guns, fourteen 6-inch rapid-firing guns and thirty-two smaller guns and five torpedo tubes. Its indicated horse-power will be not less than 14,500, supplied by twenty-five Belleville boilers. That is the sort of craft Japan is getting.

With such a navy Japan will be secure from any invasion of her island home, no matter who may try to succeed where the great Kublai failed. But besides that she will have an army that could give a good account of itself against any that could be sent to that part of the world by any other Power. At the close of the Chinese war the Japanese army consisted of 70,000 men on a peace footing and 268,000 on a war footing. The strength has now been raised to 145,000 and 520,000 respectively, apart from the gendarmerie and militia. That makes a formidable army in size. As for its quality, its conduct in the Chinese war leaves little room for doubt that it will compare favorably with

that of almost any other. The Japanese soldier appears to combine dash and spirit with dogged persistence in a remarkable degree. He has all the disregard of pain and death the most fatalistic Chinaman has and the intelligence and discipline of the European. An invading army, supposing it to get past the fleet, would have to cope with a force equal to itself, man for man, and would therefore have to be itself equal to that force in numbers. That any hostile Power will ever succeed in landing half a million men upon the shores of Japan is too improbable for serious consideration.

It may also be observed that these enormous armaments are not costing Japan a ruinous sum. The enlarged army costs for maintenance only some $14,000,000 a year, and the maintenance of the enlarged navy will cost not more than $8,000,000 a year. Of course, the total revenue of Japan is proportionately small, only about $75,000,000 a year, so that this expenditure for army and navy amounts to about 30 per cent of the whole. That is a larger proportion than is spent for such purposes by the United States, Great Britain or France, but not nearly as large as is spent by Germany. Moreover, there is every reason to suppose that the ordinary revenue of Japan will steadily and rapidly increase, so that this war tax will not prove onerous. There is little prospect of the empire falling back in the path it has entered. It is henceforth to be reckoned with as one of the great militant power.

—*New York Tribune*, January 3, 1898.

ARTILLERY MATERIAL.

a. Guns and Carriages.

The construction of modern wire-wound ordnance.

We may take for description the 12 in. gun, as made for the English Government at the Royal Gun Factory, and at Elswick, supplementing our description with other guns of various calibres, and particularly the 12 in. wire guns, eight of which have been constructed for the *Fuji Yama* and *Yashima*, of the Japanese Navy, by Sir William Armstrong and Co., and which vary in several important particulars from the 12 in. English guns, made collaterally with them.

The 12 in. service gun, 1897, consists of a barrel composed of two concentric tubes, known as the inner A tube or liner, and the outer A tube, over which is wound the wire in many layers, passing from one extremity of the gun to the other, and thus distinguishing it from all other guns, which are only reinforced on the breech portion. Outside this again are contracted two very long rather thin hoops and a short connecting collar. The great unstepped length of the chase hoop gives the 12 in. gun a very remarkable appearance. The total length of the gun from breech to muzzle is 445½ in. The weight is 46 tons, about one-quarter of this being taken by the wire, which therefore represents a length of about 100 miles.

The Japanese 12 in. gun is only strengthened with wire at the rear half, about five tons of wire being used. The arrangement of the chase hoops has, therefore, to be different to the English gun to give the necessary strength. The very long hoops cannot in consequence be conveniently used, and two shorter hoops with a stepdown are therefore employed. A double barrel is not used in this gnn.

The English specification for gun steel is as follows, an alteration in one or two points having been made within the last eighteen months :—

"Tensile test pieces for gun forgings.

Breaking strains. Tons per square inch.		Elongation. Per cent.
Not less than	Not more than	Not less than
34.	44.	17.
Tensile test pieces for breech screws. Breech-bushes and axial vents (obturators).		
38.	48.	15.

"Each test piece before testing is to be provided with two gauge points accurately adjusted to 2 in. apart, and is to be subjected in the testing machine, in the first instance, to a load of 21 tons per squre inch; should the machine record any yielding point before this load has been reached, the same is to be noted. The load is then to be entirely removed, and the test piece measured. The permanent elongation under the load of 21 tons per square inch is not to exceed 0.02 in. The load on the test piece is then to be again applied until the breaking point is reached. The bending test pieces are to be pressed flatways with a semicircular-ended presser, through one or more suitable apertures or guides, furnished or not furnished with anti-friction rollers, at the option of the contractors or makers of the steel. That flat side of the test piece which was the nearer to the centre of the gun is to be, in each case, in contact with the presser.

"This test is to be borne without the outer surface of the steel exhibiting an open crack across the whole of its width. Diameter of end of presser is to be 1.5 in., and the width of apertures, or between the guides, 2.375 in." Each tensile test piece is 4½ in. long, having a cylindrical central part 2 in. long by 0.533 in. diameter. The bending test pieces are 4½ in. long, by 0.75 in. wide, and 0.375 in. thick.

A clause is also included in the specification that all pieces which are to be ultimately pierced with a hole greater than 6 in. in diameter must be forged on a mandril, leaving a hole reasonably near to the finished size through them. Every tube, therefore, on the 12 in. gun has to be forged in this manner. The forgings are made from cast steel ingots of particular shape. They are octagonal truncated cones, superposed on a short abrutly-tapered circular base. The narrower part of this ingot is the top, and as it in consequence contains the light impurities, a great part of it, about one-third of the whole ingot, has to be cut away. The circular base is also removed. The machines used for cutting the ends off at Elwick are admirably adapted to the work. They were made by Messrs. Craven Brothers, Manchester. Each machine consists of a heavy vertical circular face-plate, rotated by a powerful worm. On this face are two flat steel cheeks, from 1 in. to 1½ in. thick, capable of movement towards each other. Let into the edges of these cheeks are the cutting tools. The action is obvious. A simple automatic gear moves the cheeks nearer and nearer together, and so feeds the cut. Sometimes superposed above the first pair of steel plates is a second similar pair so arranged that a suitable slice from which to cut test piece is ripped off. The ingot either passes through a hollow head or is supported in front only. Three large V blocks carry it. The defective material having been removed, a test of the steel for the maker's satisfaction is taken from the slice removed, which is, of course, adjacent, and practically the same as the corresponding face of the material to be used. This proving satisfactory, the ingot is then trepanned. As every one knows, a trepanning machine has a hollow instead of a solid boring bar, and the cutting tools attached to the end face of the bar, so that a circular cut is made, and as the work advances a solid core of steel enters the bar, and is, of course, available for future use. It is very rarely necessary to

trepan a large hole in an ingot. As the ingot is short, and the piece to be made from it is long, the whole substance is as a rule required, so that only a sufficiently large hole to insert a mandril powerful enough to carry the ingot is pierced.

Of late years hydraulic, or pressure forging, has almost entirely superseded hammer forging for gun work. Of course, where large hammers have been put down at great expense they are still used; but no new large hammers are now built. The effect of the press on the steel is far superior to that of the hammer. With the latter the material is acted on superficially, the tendency being, as anyone who has watched a large hammer at work on a rectangular block will have noticed, to increase the area of the surface struck disproportionately to the body of the material. With the press a reverse effect obtains; a rectangular block bulging at the sides being produced, but at the same time, the disproportion between the action on the substance and the face is less than with a hammer. For heavy work a very great hammer pressure is, of course, required, presses acting at from 2000 to 5000 tons being not uncommon, and they are usually fed at a very high pressure. The ingot is heated in an immense furnace, usually by producer gas, and when hot is lifted out on the mandril by hydraulic cranes. The mandril is slightly tapered and is hollow, a copious stream of water passing through it continuously. Near one end of it is attached a large head, and between the head and the ingot a large block of metal slides on a parallel bar, or portion of the mandril. To remove the mandril, ropes or chains are attached to this block. A few men then draw it forwards towards the ingot, the ingot resting on the anvil at the time, and a great number of men draw it back smartly against the head of the mandril. The mandril is thus hammered out till the taper allows it to be removed freely.

The hydraulic forging press is always vertical; the head is rectangular and flat-faced, but the anvil for circular work has a large triangular notch, which not only keeps the work truly in place as it is turned round and round, but distributes the pressure in the most effective manner. For revolving a large ingot or forging it is usual to attach to the end of it a great ratchet wheel with a lever and pawl worked by a chain from an hydraulic cylinder. The metal to be worked rapidly has to be intensely hot; but, as in the earlier stages of working up from an ingot, the metal is collected into a short length, and is consequently very thick, it retains its heat for a long time. The forgings for the barrel of the 12 in. English gun are about 43 ft. long, and for the Japanese gun some 5 ft. longer. Some surprise will, perhaps, be felt that such a great length of such small internal diameter, between 9 in. and 10 in., can be forged hollow satisfactorily; but it may be mentioned that failures are rare, and that much longer hollow forgings for steamship are not infrequently made.

—*The Engineer*, January 21, 1898.

b. Armor and Projectiles.

* * * * *

c. Powder and Explosives.

High explosives and modern war vessels.

It is now an acknowledged axiom that high explosives will be employed in shells. Whether naval officers object to carry them on board ship or not, they will in future be the principal ingredient by which shells are filled for coast and siege purposes; and already the nature of high explosive to be used as a

"service" bursting charge for high angle howitzers in coast and siege batteries has been practically determined.

After exhaustive trials, all inventions in this direction, except wet gun-cotten and lyddite, have been discarded. A satisfactory high-explosive has been defined as fulfilling the following conditions:—"It should be safe in manufacture, store, and transport, and stable under service conditions. It should be of a convenient form for filling shell, and safe to manipulate in the process. It must be capable of standing the shock of discharge in high-velocity guns, and must on striking detonate with violence and certainty, and without the aid of any dangerous fulminate. The explosive should be capable of having its sensitiveness increased or diminished as occasion may require, and a shell, when filled with it should not detonate when hit by another shell." "Of those high explosives experimented with, the two coming nearest to the standard are wet gun-cotton, which has been adopted by at least one European Power, and lyddite, which is used in our service." Wet gun-cotton will not detonate in a shell struck by another shell, and in this respect is more satisfactory than lyddite; but gun-cotton, to produce its best effect, must be compressed into discs to fit the interior of the shell, and the shell must therefore be made in two parts and screwed together—a source of weakness and possible danger. Dry cotton and a fulminate are, moreover, required to detonate it. Hence lyddite, to which none of these objections apply, will probably be adopted as the high explosive of our service.

Such being the case it is interesting to note the character and appearance of lyddite. Under the name of picric acid it has long been known. Picric acid is a nitro-substitution compound obtained by the action of nitric acid on a variety of substances; for example, indigo, silk, acaröid resin, etc., but on the commercial scale the substance now generally acted on by the nitric acid is carbolic acid, and the equation of the process is simple, viz.:—

$$\underset{\textit{Carbolic acid.}}{C_6H_6O} + \underset{\textit{Nitric acid.}}{3\,HNO_3} = \underset{\textit{Picric acid.}}{H\,.\,C_6H_2\,.\,3\,NO_2\;O} + 3\,H_2O.$$

Picric acid may, as written above, be regarded as a picrate of hydrogen, which latter element can be displaced by a metal to form an ordinary picrate —for instance, picrate of potassium, $K\,.\,C_6H_2\,.\,3\,NO_2\,.\,O$. It is a crystalline substance of a brilliant yellow color, and is intensely bitter to taste. It burns with a very smoky flame. It is largely used as a dye, or constituent of dyes, and has not been usually considered as an explosive. Nor, indeed, does it usually behave like an explosive under ordinary circumstances, though under special conditions easily produced, it is capable of developing its now well-known formidable explosive properties. It may be burnt away in an unconfined state in considerable quantity without explosion, but the mere contact of certain metallic salts or oxides with picric in the presence of heat developes powerful explosives which are capable of acting as detonators to an indefinite amount of the acid, wet or dry, which is within reach of their detonative influence.

Lyddite has proved to be a fairly stable compound, and safe in manufacture, store and transport. High temperatures aboard, or in ships' magazines, do not affect its condition. When carefully packed into shells it does not "set back," like the nitro-glycerine in dynamite, on the shock of discharge, and so interfere with the "exploder," or create a condition of extreme danger, from the likelihood of a premature. Several accidents have occured during the fire of shells charged with lyddite, from this last-mentioned cause, viz., the

projectile prematurely exploding in the bore of the gun. But in the majority of cases the causes of the disaster were traced to faults in the shell, and were not due to over-sensitiveness of the lyddite. Shells to contain it are now made of the best forged steel, which minimises the prospect of prematures. The action of a powder fuze will not detonate lyddite, hence an exploder containing a few ounces of a safe and stable explosive is employed. It is inserted in a hole drilled centrally in the charge. The actual nature of the exploder used by the War Department is kept secret, but many metallic oxides and nitrates will detonate when brought into contact with picric acid at a high temperature, and this fact has probably been taken advantage of by the chemical department.

Clearly, then, the high explosive shell has a very marked future before it, for artillery fire or active service; and, as foreign Governments have gone even further than we have in the development of this terribly effective projectile—for one European navy, at least, has already introduced the mélinite shell into its magazines on board ship—we must be prepared for attack with high explosive shells in the next naval action, not only from shore batteries, but from the enemy's vessels.

This is a serious outlook. Take the cases of the *Majestic*, *Powerful*, or *Diadem* types. Probably the 6 in. Harveyised steel armor plates upon the 6 in. gun casemates of these vessels would break up or explode outside the majority of high-explosive shells with which they might be attacked, and the side and barbette armor would certainly be sufficient to effect this desirable end; but the whole of the upper deck battery would be at the mercy of a few high-explosive shells which should burst within it, either from contact with a 12-pounder mounting or any other cause, and the whole of the main deck space from stem to stern, except the eight closed-in casemates, including the entire series of officers' cabins, would be mere shambles in a quarter of an hour. If anyone doubts the probability of this, let him go over the *Resistance* and judge for himself. She is an object lesson, the value of which cannot be controverted.

But, it may be asked, is there any remedy for such a condition of terrible insecurity as regards the officers and crews of our war vessels in the future should the high-explosive shell do all that is expected of it? We believe that there is a partial remedy, but we fear not one that will commend itself in the eyes of our naval constructors. Looking at the *Powerful* or *Diadem*, the enormous freeboard given to these types cannot but excite observation. Is it excessive or not? That is the question. We cannot help thinking that, in running away from the evils of low freeboard, we have now run into the opposite extreme, if only the casemates can be adequately protected with armor against high-explosive shells, whilst vessels of so high a degree of freeboard are being built. We would cut them down in future and utilise the saving in weight of material thus released to provide a more extensive system of armor protection over the reduced surface of the ship's sides. As the *Powerful* and *Diadem* types are at present they are merely huge targets, which will be the sport and pastime of an energetic enemy, who may possess guns firing high-explosive shells; their only chance in action would be to at once crush their enemy with their own high explosives, or run away and trust to the diminishing perspective of their form as they disappear over the horizon for the chance of not being hit. As regards our battleships, it is difficult to suggest anything; but surely a *milieu* could be designed between

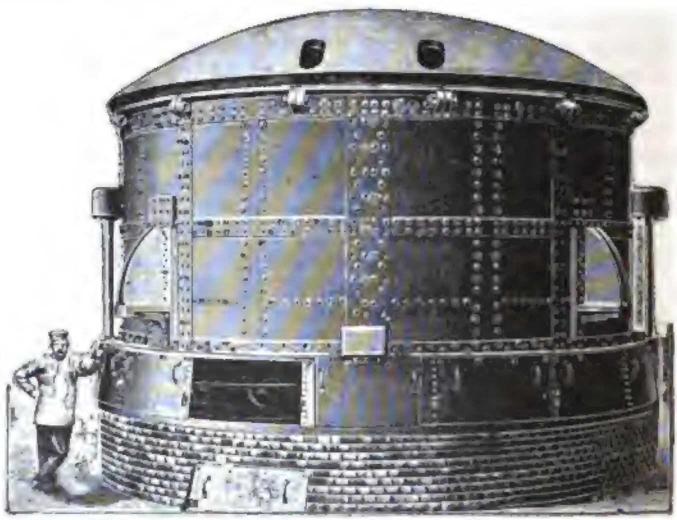
the *Nile* and *Trafalgar* which possess almost perfect immunity from the chance of destruction between decks by high-explosive shells, and the *Majestic*, which has none whatever above the main deck. Here is food for reflection.

—*The Engineer*, December 24.

FORTIFICATION.

Armored Cupola for Fort Wealhem, constructed at the Ateliers de Construction de la Meuse, Liège.

Belgium for centuries enjoyed the doubtful dignity of being the cockpit of Europe, and its people are far from anxious to repeat their previous experiences in this line. It is true that the independence of the Belgian soil is under international guarantee, but in cases of emergency such safeguards are too likely to prove illusive, and the campaign of Ulm furnishes a precedent for the violation of neutral territory, if great strategic advantages are to be gained thereby. Belgium has accordingly deemed it prudent to reinforce such protection as is afforded by treaty by the establishment of a formidable series of modern forts, equipped with heavy guns fixed in an armored turret or cupola



of the type originally introduced by General Brialmont. One of these cupolas, constructed by the Ateliers de Construction de la Meuse, Liège, is illustrated above, and photographs of it were shown at the Brussel Exhibition. The cupola differs from a ship's turret in the fact that the body being sunk in a pit, the sides do not require armoring, whilst the top, being domed, it is very unlikely to be struck a fair blow by an enemy's projectile. Experience has shown very conclusively the great resisting power of inclined armor. The particular cupola illustrated has been built for the Waelhem fort, and takes two 150-centimetre (5.9 in.) guns. Very complete tests of the plant were made by the authorities last December and January. One hundred rounds were fired from the guns with full service charges, each charge comprising 19.8 lb. of brown prismatic powder, and a shell weighing 108 lb. At the conclusion of the trial the whole of the working parts, including the springs for

taking up the recoil, were found in excellent condition. It was ascertained, moreover, that the guns could be trained through 27 deg. in from 25 to 30 seconds. Special attention has been devoted to the ready mounting and dismounting of the guns, one of which can, it is found, be removed and replaced in 65 minutes. The cupola can be rotated at the rate of one complete revolution in 60 seconds, when six men are employed to work the turning gear; four men, it was found, could make a turn in 75 seconds, and two men in 150 seconds.

Engineering, December 24, 1897.

MILITARY GEOGRAPHY.

Hawaii.

LOCATION.

The Hawaiian Islands are near the middle of the North Pacific Ocean, between 18 and 22 degrees North Latitude and 154 and 160 degrees West Longitude.

The following map shows their position, better than any description.

Without disputing Boston's claim to be the hub of the Universe, Hawaii is the hub of the Western Hemisphere.

STRATEGICAL POSITION.

Hawaii is the only spot in the Pacific, from the Equator on the South to Alaska on the North, and between America on the East and Asia on the West, where water, food or coal can be obtained. It is also on or near the principal trade routes across the Pacific. Its unique position is what has given it the name of "*The Cross Roads of the Pacific*," "*The Key of the Pacific*," and "*The Gibraltar of the Pacific*."

CAPTAIN MAHAN'S OPINION.

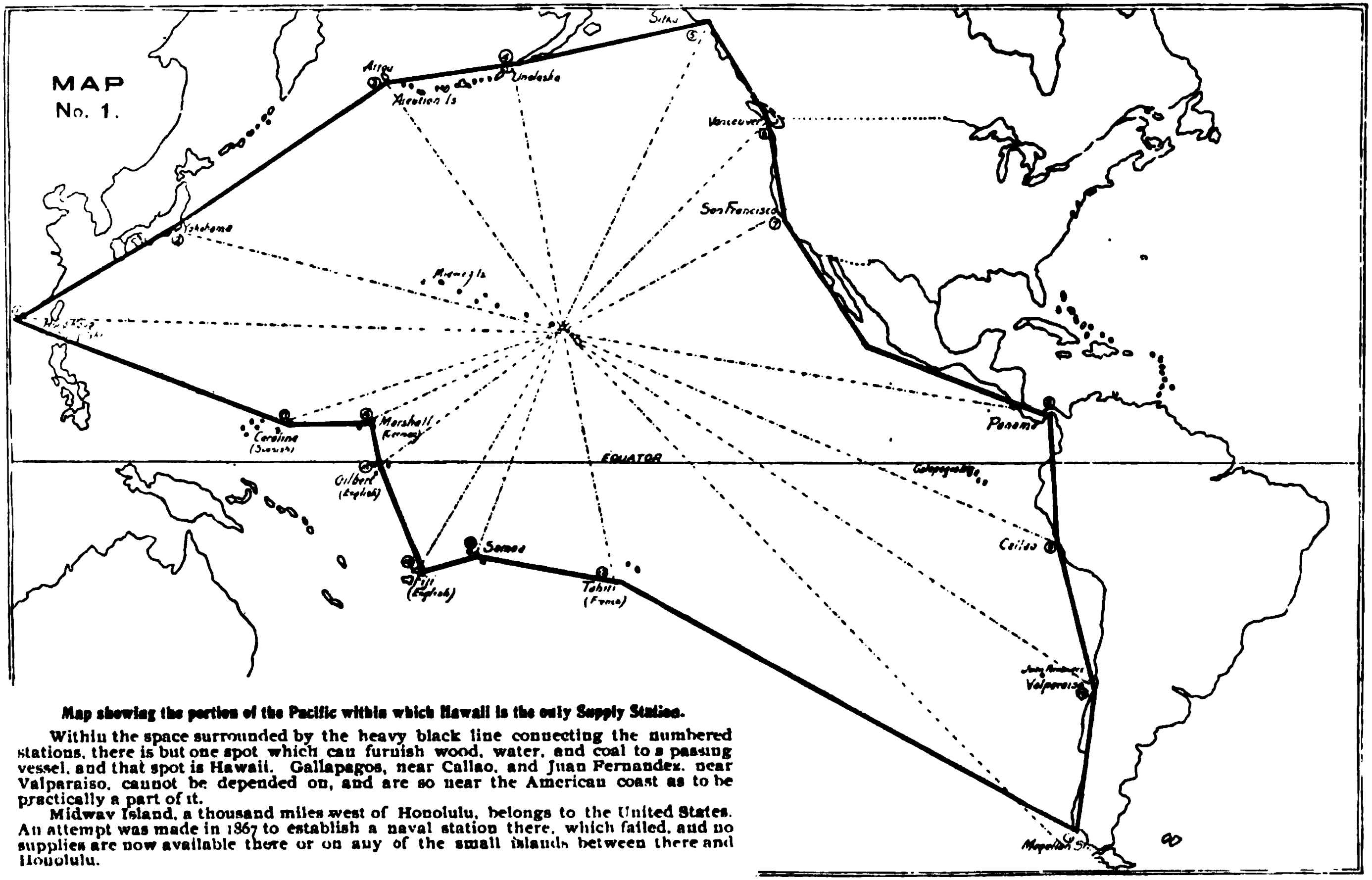
Captain Mahan, of the U. S. Navy, one of the highest authorities on naval strategy, says that Hawaii is one of the most important strategical points in the world; that it stands "alone, having no rival and admitting no rival."

The distances to the principal Pacific ports are as follows:

Hawaii	to	San Francisco	2080	Miles.
"	"	Nicaragua Canal	4210	"
"	"	Tahiti	2389	"
"	"	Pagopago, Samoa	2263	"
"	"	Auckland, New Zealand	3850	"
"	"	Fiji	2736	"
"	"	Marshall Islands	2098	"
"	"	Caroline Islands	2602	"
"	"	Hong Kong	4917	"
"	"	Yokohama, Japan	3399	"
"	"	Unalaska, Aleution Islands	2016	"
"	"	Sitka	2395	"
"	"	Vancouver	2305	"

NUMBER AND AREA OF ISLANDS.

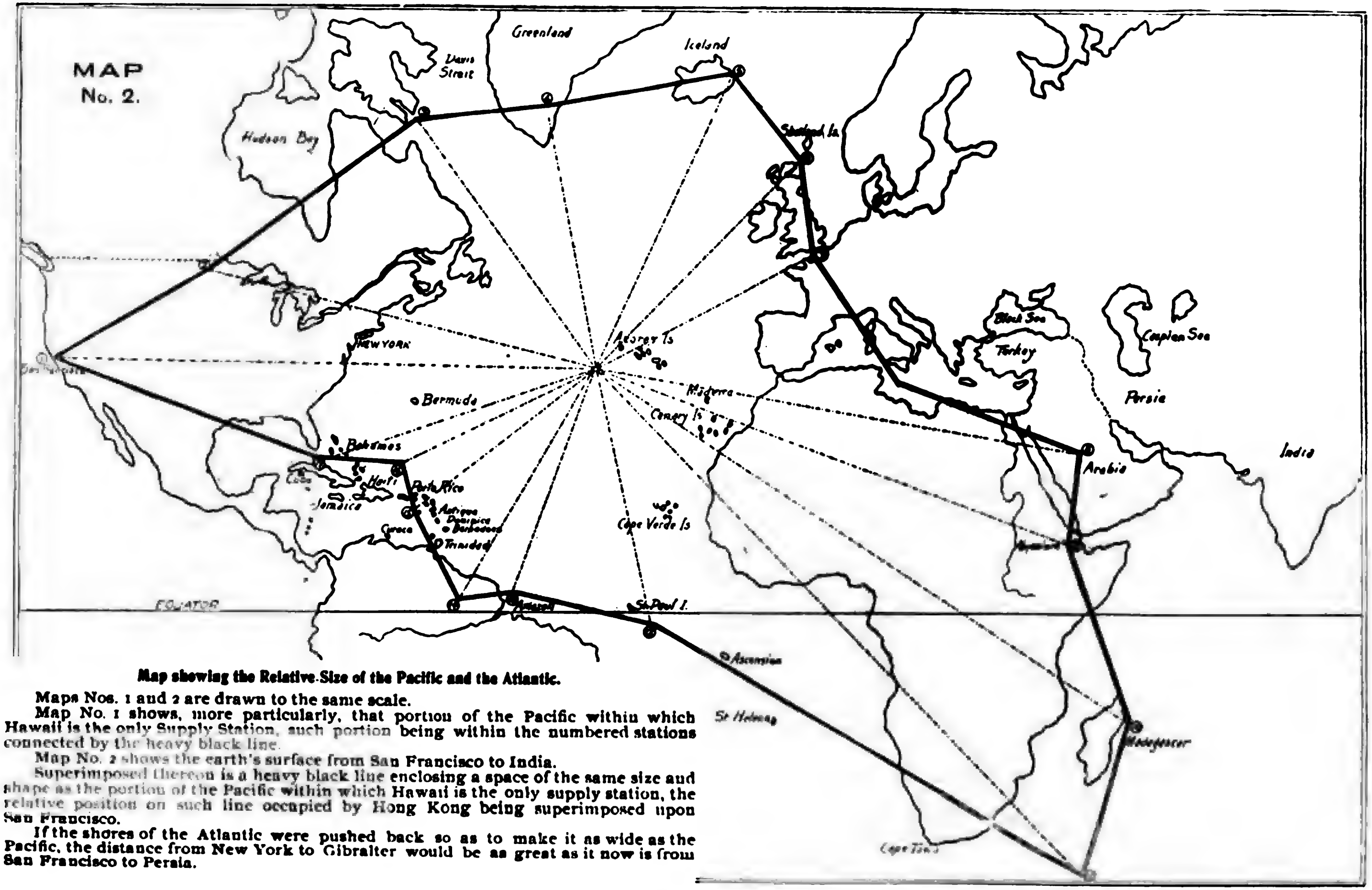
The group contains eight inhabited islands and a large number of small uninhabited ones, of a total approximate area of 7000 square miles, or 4,480,000 acres; being nearly the area of Massachusetts, and considerably larger than Connecticut and Rhode Island combined. The group extends east and west a distance of 1200 miles. The eight principal islands cover 300 miles at the eastern end of the group. They are Ha-wai-i, Mau-i, O-a-hu, Kau-ai, Mo-lo-kai, La-nai. Ka-hoo-la-we and Ni-i-hau. There are valuable guano and phosphate rock deposits on some of the western islands.



Map showing the portion of the Pacific within which Hawaii is the only Supply Station.

Within the space surrounded by the heavy black line connecting the numbered stations, there is but one spot which can furnish wood, water, and coal to a passing vessel, and that spot is Hawaii. Gallapagos, near Callao, and Juan Fernandez, near Valparaiso, cannot be depended on, and are so near the American coast as to be practically a part of it.

Midway Island, a thousand miles west of Honolulu, belongs to the United States. An attempt was made in 1867 to establish a naval station there, which failed, and no supplies are now available there or on any of the small islands between there and Honolulu.



Map showing the Relative Size of the Pacific and the Atlantic.

Maps Nos. 1 and 2 are drawn to the same scale.

Map No. 1 shows, more particularly, that portion of the Pacific within which Hawaii is the only Supply Station, such portion being within the numbered stations connected by the heavy black line.

Map No. 2 shows the earth's surface from San Francisco to India. Superimposed thereon is a heavy black line enclosing a space of the same size and shape as the portion of the Pacific within which Hawaii is the only supply station, the relative position on such line occupied by Hong Kong being superimposed upon San Francisco.

If the shores of the Atlantic were pushed back so as to make it as wide as the Pacific, the distance from New York to Gibralter would be as great as it now is from San Francisco to Persia.

HO-NO-LU-LU.

Situated on the island of O-a-hu, is the principal city and the capital of the Republic.

It is located on a small but safe harbor, and has a population of 30,000.

The business portion is well built of stone and brick; the residences are of wood.

The city has 67 miles of street and drives, of which 20 miles are macadamized; has a street railway system; public and private electric light system; a telephone system extending throughout the island and using 1300 telephones; a well regulated State prison; handsome executive buildings, Custom House and Court House; an Insane Asylum, Public Hospitals, Maternity House, Old Folks Home; Public Library; a well equipped Y. M. C. A. building; banks; churches; public and private schools; public water works, both a reservoir and pumping plant; a paid fire department equipped with the most modern steam and chemical engines; has a G. A. R. Post; branches of the Societies of "Sons" and "Daughters" of the American Revolution, and numerous Masonic, Odd Fellows and other similar Lodges. In other words, it has the appliances and conveniences of an up-to-date American city, with the added charm of a profuse tropical vegetation, and a climate unrivalled the world over for mildness and evenness.

The city lies on a level strip of land along the sea, a mile or two wide and five miles long, and extending back for several miles into five valleys, which cut deep into thickly wooded, cloud-capped mountains rising to an elevation of nearly 4000 feet at a distance of six miles from the sea.

GENERAL PHYSICAL CHARACTERISTICS OF THE COUNTRY.

The islands are all high and mountainous, rising to a height of 4000 feet on Oahu, to 10,000 on Maui, and 14,000 feet and perpetual snow on the island of Hawaii. The whole country is volcanic in origin, there being hundreds of extinct and two active volcanoes.

Each island consists of one or more mountains seamed with valleys and gorges, with rolling plains lying between the mountains, and generally fringed with a comparatively level belt along the sea shore.

Some portions of the coast are protected by reefs of coral, while others are sheer precipices rising out of blue water to a height of thousands of feet.

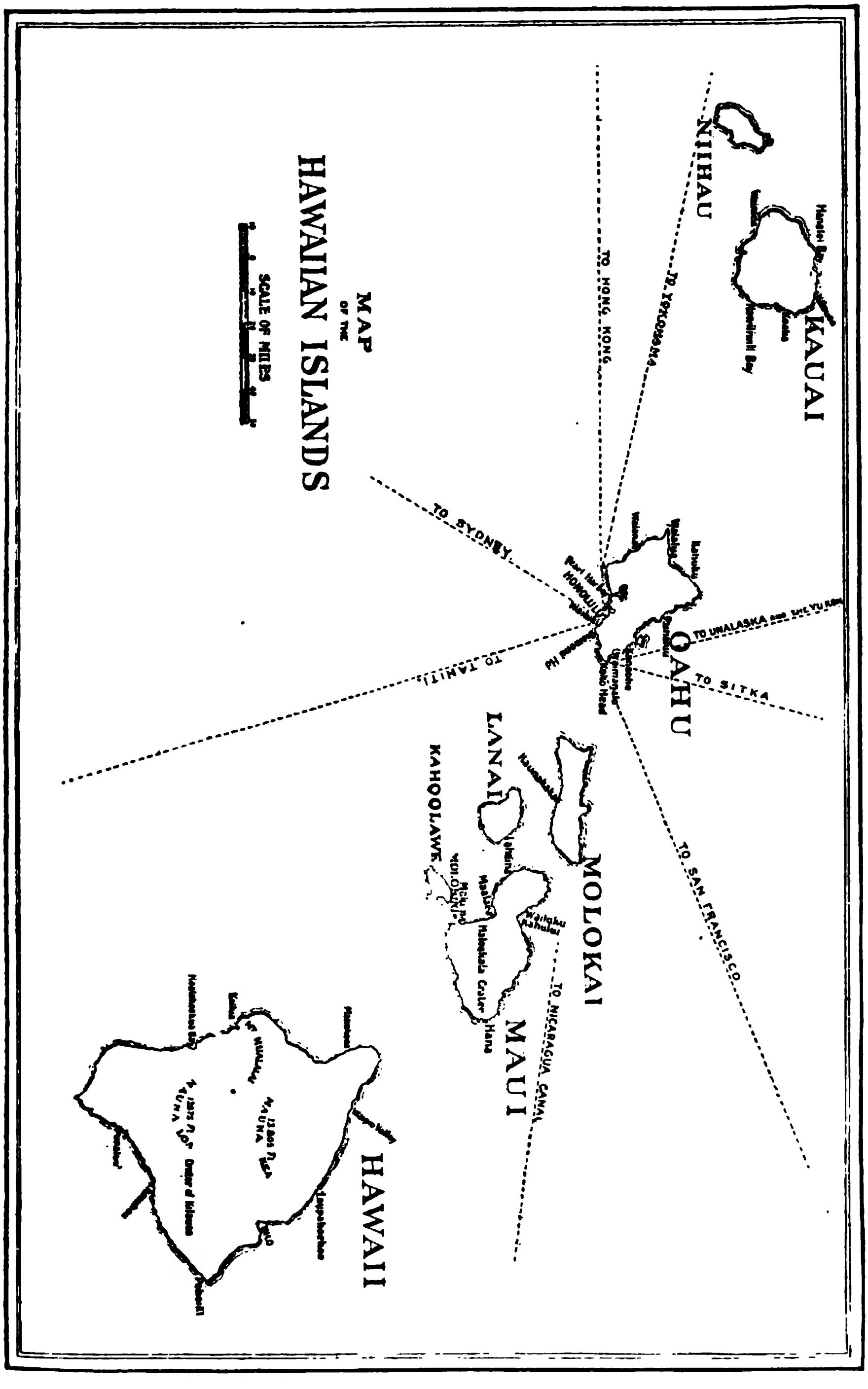
The Soil, consisting of decomposed lava, is fertile; but has to be irrigated in many places, the water coming from mountain streams, artesian and surface wells. Some of the largest steam pumps in the world are used, raising water to an elevation of 400 feet.

Fertilizers are used in large quantities, thousands of tons per annum being used on the sugar plantations.

The Climate, is mild and even, being of an average weekly maximum of 74 in winter and 82 in summer. There are no extremes of heat or cold. The lowest temperature at sea level in winter, is about 56° and the hottest in the summer about 88°. A temperature of 90° in the shade is almost unknown. At higher elevations above the sea almost any desired temperature can be found. On two mountains there is perpetual snow.

The cool northeast trade winds blow for nine months of the year. Except when the south winds blow the humidity of the air is low.

The country at all elevations, and throughout the year, is healthy, the death rate among whites being exceptionally small. None of the fevers and other


MAP
OF THE
HAWAIIAN ISLANDS
SCALE OF MILES
NIIHAU
KAUAI
OAHU
MOLOKAI
LANAI
KAHOOLAWE
MAUI
HAWAII
TO HONG KONG
TO YOKOHAMA
TO SYDNEY
TO TAHITI
TO SITKA
TO SAN FRANCISCO
TO NICARAGUA CANAL
Haleakala Crater
Wailuku
Kahului
Hana

typical diseases of tropical countries are found there, and the diseases of the temperate zone are usually of a mild character.

The climate is so balmy and natural conditions so delightful that, by common acceptance, Hawaii is known as "The Paradise of the Pacific." Although spoken of as a "tropical country" it is barely on the edge of the tropics, and the same Arctic current that cools San Francisco gives Hawaii a climate many degrees cooler than in the same latitude in the Atlantic. It is a climate well suited to the physical and mental development of the Anglo Saxon.

Products. The principal products are sugar, rice, coffee, bananas, pine apples, guavas and other tropical fruits, many of which grow wild.

Sugar. The area cultivated with sugar cane is approximately 80,000 acres. The export of sugar in 1896 amounted to 221,000 tons. The output of sugar cannot be much increased, as most of the sugar lands are already occupied.

Coffee. The cultivation of coffee is rapidly increasing. It will soon rival sugar in amount and value, as there are large areas of rich but yet uncultivated land, not available for sugar but peculiarly adapted to coffee. This product is the hope of the country, as it can be produced profitably by farmers with small capital.

Bananas and Pine Apples. The principal supply of these fruits consumed on the Pacific Coast is from Hawaii. It is a growing trade.

The Rainfall varies greatly, ranging from fifty inches in some districts to 175 inches in others. Irrigation supplements the rainfall in the dryer section. Two-thirds of the sugar is produced by irrigation.

Education. There is a highly organized system of free public schools, modeled on that of the United States, in which the English language is taught. There are also a number of private boarding schools, and schools ranking with high schools in the United States.

The public school year is eight months, and all children between six and fourteen years of age are compelled, if physically able, to attend school.

All the Hawaiian born population of all nationalities can read and write English. The number of schools in 1896 was 187; number of teachers 426; number of scholars 12,616.

The schools are under the control of an unpaid board of five persons, appointed by the President.

The constitution prohibits the appropriation of public funds for sectarian or private schools.

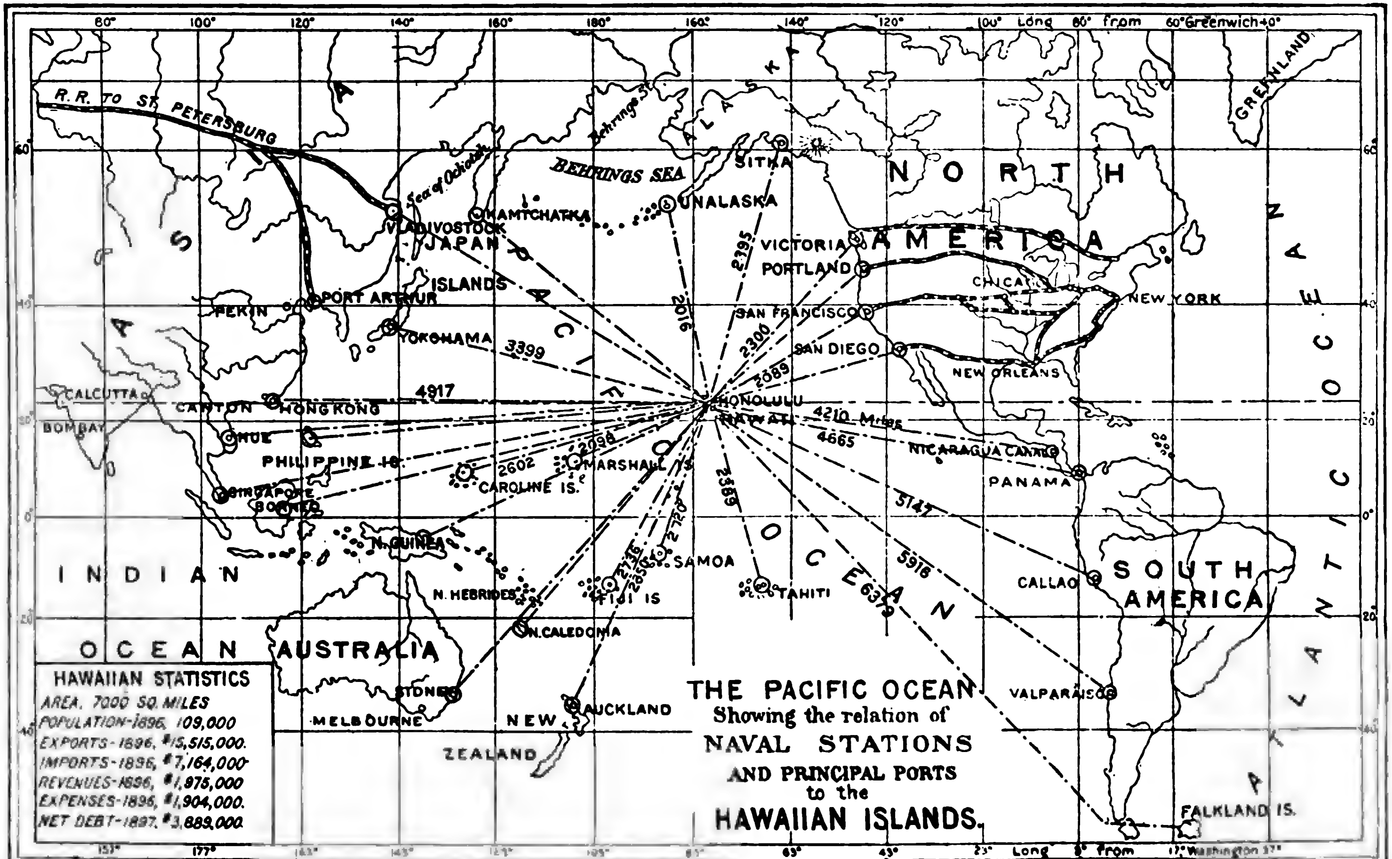
The question is frequently asked, how the possession of Hawaii, 2000 miles distant from the continent, will secure control of the North Pacific, and why Hawaii is more necessary to the Pacific Coast than are the Azores, which are about the same distance off the Atlantic Coast, necessary to the protection of the United States on the Atlantic side?

The reasons why Hawaii is essential to the protection of the Pacific Coast, and why the Azores are not necessary to the protection of the Atlantic, are as follows:

In the first place, the distance across the Atlantic is approximately 3000 miles.

The distance across the Pacific is from 7000 to 9500 miles.

Second: All of the Great Powers of Europe lie, or have coaling stations, within steaming distance of the Atlantic Coast of the United States. On the other hand no nation, European or Asiatic, lies, or possesses a coaling station, near enough to the Pacific Coast to be practicably available, as a base of hostile naval operation against that Coast or its commerce.


THE PACIFIC OCEAN
Showing the relation of
NAVAL STATIONS
AND PRINCIPAL PORTS
to the
HAWAIIAN ISLANDS.
HAWAIIAN STATISTICS
AREA, 7000 SQ. MILES
POPULATION-1896, 109,000
EXPORTS-1896, $15,515,000.
IMPORTS-1896, $7,164,000
REVENUES-1896, $1,975,000
EXPENSES-1896, $1,904,000.
NET DEBT-1897, $3,889,000
R.R. TO ST. PETERSBURG
BEHRINGS SEA
NORTH AMERICA
SOUTH AMERICA
AUSTRALIA
INDIAN OCEAN
PACIFIC OCEAN
ATLANTIC OCEAN
HONOLULU
SAN FRANCISCO
PORTLAND
VICTORIA
SAN DIEGO
SITKA
UNALASKA
YOKOHAMA
HONG KONG
SAMOA
TAHITI
AUCKLAND
SYDNEY
PANAMA
CALLAO
VALPARAISO
NEW YORK
NEW ORLEANS
CHICAGO
FALKLAND IS.
4210 Miles

British Columbia is not a material factor in this connection; for, in case of hostilities between England and the United States, all Canadian territory would be so speedily overhelmed by invasion from the United States that its ports would not cut any material figure as hostile bases of operation for any considerable length of time.

Third: On the Atlantic there are scores of islands which can be used as bases of naval supply and repair. There are not only the Azores, Madeira, Canary, Cape Verde, Bermuda, Newfoundland, and the Bahamas, but the vast number of West India Islands.

On the other hand; in the whole Pacific Ocean from the Equator on the South, to Alaska on the North; from the Coast of China and Japan on the West, to the American Continent on the East, there is but one spot where a ton of coal, a pound of bread, or a gallon of water can be obtained by a passing vessel, and that spot is Hawaii.

The immensity of this area of the earth's surface is comprehended by but few.

The distance from Hong Kong, through Hawaii to Panama, is 9580 miles. This distance is as far as from San Francisco eastward across the continent, across the Atlantic, across the Mediterranean, and across Turkey to the boundary of Persia.

The first supply station north of Hawaii is at Unalaska in the Aleution Islands, and the first similar station on the south is Tahiti, a French Colony.

The distance between Unalaska and Tahiti is 4400 miles; as far as from the southern point of Greenland to the mouth of the Amazon river.

The Atlantic is, comparatively, so narrow, that way stations are not absolutely essential; while the islands in the Atlantic north of the Equator, capable of use as way stations are so numerous that it is practically impossible for the United States to absorb them all.

On the other hand, the width and size of the North Pacific is so great that no naval vessel in existence can carry coal enough to cross the Pacific from any of the existing or possible foreign naval stations, to the Pacific coast of the United States, operate there and return, without recoaling. A modern battleship without coal is like a caged lion—magnificent but harmless.

One of the first principles in naval warfare is, that an operating fleet must have a base of supply and repair.

Any country in possession of Hawaii would possess a base of operations within four or five days steaming distance of any part of the Pacific Coast.

Without the possession of Hawaii, all of the principal countries possessing interest in the Pacific, are so far away that the distance is practically probibitory of hostile operations against the Pacific Coast. For instance, the nearest English station is forty-six hundred miles distant from San Francisco. The nearest French station is thirty six hundred miles distant. The nearest Spanish station is forty-seven hundred miles distant. Russia is forty-seven hundred miles away; Japan forty-five hundred miles, and China fifty-five hundred miles.

The United States, in possession and control of Hawaii, will thereby, by simply keeping other nations out, afford almost absolute protection on her Pacific Coast and commerce from hostile naval attack. On the other hand, Hawaii, in possession of any foreign country, will be a standing menace against, not only the Pacific Coast, but against all of the Ocean-bound commerce to and from that Coast, and all American commerce on or across the North Pacific.

The Importance of the relation of Hawaii to the commerce of the Pacific is demonstrated by the fact that of the seven trans-Pacific steamship lines plying between the North American Continent and Japan, China and Australia, all but one make Honolulu a way station.

It is for the reasons above set forth that Hawaii has for the last fifty years been currently known to Statesmen and Naval Authorities as "The Key of the North Pacific," and that American Statesmen, regardless of party, have consistently and persistently maintained the policy that the United States could not allow any foreign government or people to colonize or control Hawaii.

Upon the opening of the Nicaragua or Panama Canal, practically all of the shipping bound for Asia, making use thereof, will stop at Honolulu for coal and supplies.

Hawaii is today, the main stay of the American merchant marine engaged in deep-sea-foreign trade.

The number of American vessels entering American ports during the year June 30, 1896, were:

From the United Kingdom	88
From Europe, Asia, Africa, Australia, and Oceanica combined	210
From Hawaii	191

Or, in other words, Hawaii furnished cargo for 191 American ships, and all the world besides, outside of the American continent, furnished cargo for only 298 American ships.

It is the habit of those who oppose the annexation of Hawaii, to ridicule the possibility of any foreign government taking any action in or towards Hawaii inimical to the interests of the United States.

One of the best methods of judging the future is to examine the past.

Within the past eighty-five years, Hawaii has been taken possession of:

Once by Russia.

Once by England.

Twice by France.

And by reason of hostile demonstrations by foreign governments, creating the fear of foreign conquest, an absolute cession of the sovereignty of the country to the United States was executed and delivered in 1851, and a treaty of annexation negotiated in 1854.

Since 1874, on four separate occasions, internal disturbances have required the landing of foreign troops from war ships, for the protection of the interests of the several nations there represented.

During the past few years there has not seemed to be any likelihood of conflict between the United States and any other foreign powers, and many persons have concluded that there is no possibility of conflict in the future.

While the tendency of the age is undoubtedly in favor of arbitration and against war, the existing conditions in the world are not such as to guarantee that the millennium is near at hand, and more particularly are the developments in the Pacific such as to render it unsafe for any country possessing interests therein to act upon the supposition that there will be no conflict of interests in that locality.

Russia has heretofore been a European country, with but a nominal interest in the Pacific. Within the past five years it has developed Pacific wards, until it fills the northwestern horizon, and with the now rapidly progressing development of its vast empire on the Pacific coast of Siberia; the construction of its transcontinental railway from St. Petersburg to the Pacific, and the

fore-shadowed absorption of northern China, there can be no prediction of the limit of its interests and strength in the Pacific.

The meteor-like projection of Japan into the international sky, is too recent and vivid to need any enumeration of detail. In the short space of a year Japan has become not only a Pacific, but a world power.

With its rapidly increasing population, already numbering nearly fifty million; its navy now stronger than any other in the Pacific; its demonstrated power of organization and military execution; its progressive commercial and aggressive national spirit, there is no safety in basing any calculations upon the meekness or weakness of Japan.

Whether the government of Great Britain will voluntarily engage in hostilities with the United States, may be doubted; but there is a great Anglo-Saxon community growing up in the Pacific, including Australia, New Zealand, and hundreds of islands within their sphere of influence, whose interests are so great as to radically affect and frequently control British policy. This great Anglo-Saxon community inhabiting a country larger than the United States, excluding Alaska, is in the spring tide of its development. Its leading statesmen have repeatedly and publicly advanced the claim that the control of the Pacific was theirs, by right. Today, their influence and strength is not sufficient to be a serious menace to other interests in the Pacific. What their power may be fifty, or a hundred years from now, no man can tell. The statesmen of the United States should look, not to the condition of today only, but should stake out and secure to the United States the position and policy which that country may require for a hundred years to come.

—*Shall Hawaii be Annexed. L. A. Thurston.*

The new Concrete and Steel Government Docks at Puerto Cabello, Venezuela.

A concrete and steel dock of rather novel construction was completed during the past summer at Puerto Cabello, a harbor on the Caribbean Sea, abont 80 miles west of Caracas, Venezuela. Puerto Cabello is the second port in commercial importance and probably the first in natural and geographical advantages in the republic of Venezuela. It is situated on a peninsula, the northern extremity of which forms the wharf front where the new dock has been built. Lying to the north and east of the port are several islands connected by coral reefs, which form a natural breakwater, behind which lies what is called the inner harbor. This inner harbor is reached by traversing a bay several miles in extent and having a depth of water of from 60 to 100 ft. Owing to the natural protections the waters of the bay and harbor are always tranquil, and from this fact comes the name Puerto Cabello, or "port of hair," by which the early Spanish sailors strove in a rather fanciful way to commemorate the fact that they could anchor their vessels by a hair and have them ride safe from storm.

The construction of the new dock has proceeded with true tropical leisure; work having being begun in February, 1885, and completed in July, 1897. The extreme length of the dock is 450 m. (1,476 ft.), and it consists of a steel and concrete platform supported on steel piles. The portion of the platform intended for vessels of heavy draft is 8 m. (26.24 ft.) wide and 2 m. (6.54 ft.) above high tide, and the portion intended for vessels of light draft varies in width from 4½ m. to 6 m. (14.76 ft. to 19.68 ft.) and is 3.22 ft. above high tide.

A retaining wall was first built along the shore to hold back the sand. This wall is supported on timber piles 30 cm. (0.98 ft.) in diameter driven 6 m. (19.68 ft.) into the bottom, and is 6 m. (19.68 ft.) high, 3 m. (9.84 ft.) wide at

the bottom, 75 cm. (2.46 ft.) wide at the top and is vertical on the face and battered on the back. Parallel to this wall and 2.65 m. (8.69 ft.) from its face was driven a row of steel piles 20 cm. (0.65 ft.) in diameter. The piles are spaced 7 m. (22.96 ft.) apart c. to c. A second row of piles, also spaced 7 m. apart, and 3 m. (9.84 ft.) from the first row, was next sunk. The piles in this last row are 30 cm. (0.98 ft.) in diameter. The piles in each row are connected by I-beams resting in U-shaped caps fastened to the tops of the piles, and the two rows of piles are braced together by I-beams bolted to the main I-beam stringers. All this metal work was protected before erection with a coating of magnetic oxide, then an enamel coating and finally three coats of oxide of lead paint, and after erection it was covered with an armor of Portland cement mortar.

The steel piles were composed of hollow tubes fastened together by collar joints. The bottom section carried a pointed shoe and the top section carried the U-shaped socket casting previously mentioned. The method of sinking was to connect a sufficient number of sections on shore to bring the top of the pile well above water when lowered and then to drive the pile with a pile driver, adding new sections as the pile descended. Generally the piles were driven about 13 m. (42.64 ft.) into the bottom, which consisted of decomposed shell detritus mixed with mud. After the driving was completed a diver fastened a disk 1 m. (3.28 ft.) in diameter to each pile close to the bottom and a few blows were then given the pile to settle the disk firmly on the bottom. The hollow interior of the pile was then filled with concrete, and the cement mortar casing was built around the outside. To place this casing an iron cylinder composed of sections and 80 cm. (2.62 ft.) in diameter was slipped over each pile and the annular space filled, using shovels with long handles, when the depth of water was not very great, and a sort of tongs terminating in a closed box when the depth was over 4 m. (13.12 ft.). These tongs kept the mortar away from the water and enabled it to be placed without danger of washing the cement away.

The I-beam framework of the platform was also protected by a cement mortar casing. For the casing under water a composition of one part cement and one part sand was used, and for that above water the composition was one part cement and two parts sand. The frame work of concrete and steel was covered with a plank floor.

This system of concrete and steel dock construction is, it is stated, the invention of the firm of N. A. Paquet & Co., of Caracas, Venezuela, who were the contractors for the dock at Puerto Cabello. Mr. Thomas Llamozas was chief engineer of the work, which was carried out by the Venezuelan Government, at a cost of 1,900,000 bolivars, or about $1,543,000. For the information from which this description has been prepared we are indebted to Mr. S. W. Casartelli, of Caracas, Venezuela.

Engineering News, December 23, 1897.

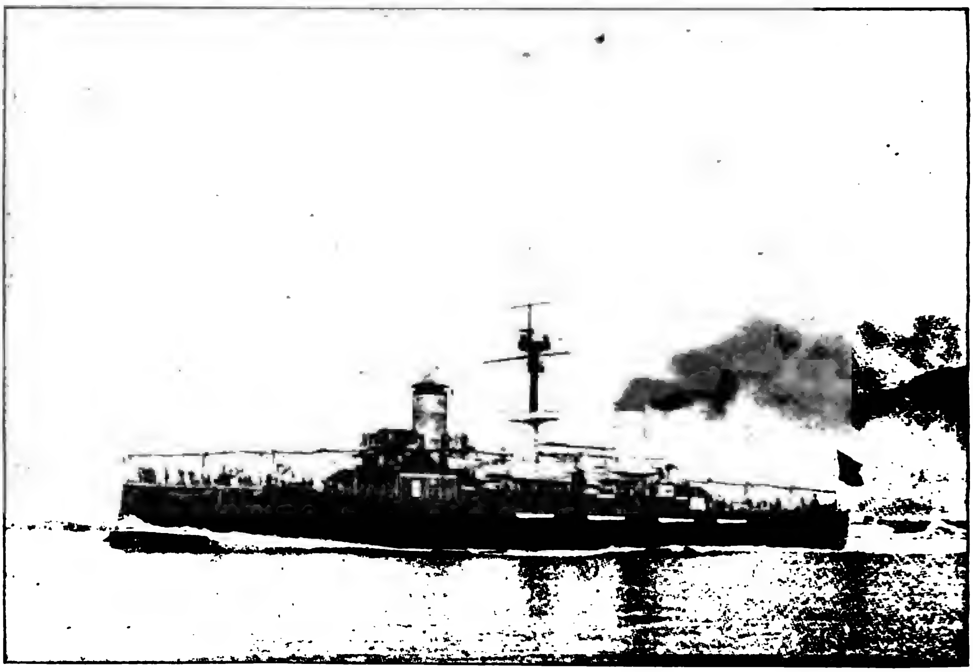
War-Ships and Torpedo Boats.

The Spanish Armored Cruiser *Cristobal Colon.*

The Ansaldo Works, of Genoa, where this superb vessel was built, were founded in 1846, and are considered the most important in Italy. They occupy an area of 220,000 square meters, and use a motive force of 1800 horse-power, and more than 1000 engine tools. The 11,500 workmen, composing the personnel of this establishment are distributed among four principal works:

Sampierdarena, where the engines are made, Sestri-ponente where the hulls are laid, Cornigliano, where the metallargical works are located, and finally, in the port of Genoa, where are the work-shops for the repair and completion of the floating structures.

The *Cristobal Colon* is the second ship constructed in Italy (and at the same works) for a foreign government; the first was the *Garibaldi*, delivered to the Argentine Republic, which differs from the *Cristobal Colon* only in the disposition of the lighter artillery and in the type of boilers used; those of the *Cristobal Colon* are of the Niclausse multitubular system, already in use in the French navy on the *Friant*, the *Elan*, the *Menhir*, etc., while those of the Argentine ship are cylindrical. The plans of the hull of the *Cristobal Colon* are by Commander Masdea, director-general of naval construction at the Italian Navy Department; its characteristic features are as follows:



Length between perpendiculars	100 m.
Beam, maximum	18.50 m.
Draught	7.10 m.
Displacement	7000 tons.

Protection is obtained by an armored belt of 15 cm., extending along the entire water line, composed of plates of nickel-steel from the works of Terni; above this belt is arranged the battery, extending over about ⅔ of the length of the ship; it is armored in front and rear, as well as on the sides, by plates also of nickel-steel, varying in thickness from 12 to 15 cm.; the ceiling of the battery is composed of steel plates 5 cm. thick, and transverse partitions separate the pieces, one from another. The two barbette turrets which carry the heavier guns are protected by steel plates 12 cm. thick, and rest at their

lower edge on the ceiling of the battery. Finally, an armored, turtle-back deck, 25 to 30 mm. thick, extends over the entire length of the ship.

The vessel was built in sixteen months.

Armament.—The armament comprises:

1. Two guns of 254 mm. in the two barbette turrets, one forward and one aft; 2. Ten 152 mm. rapid fire guns in the armored battery, five on each board-side; two of them can be used in a chase, and two others in a retreat, 3. Six rapid fire guns of 120 mm., protected by steel shields, placed on the deck; two of these guns can fire in a chase, two others in retiring; 4. The lighter guns scattered over the deck and in the military top; they comprise six 57 mm. and two 37 mm. rapid fire guns, and two machine guns; 5. Five Schwarkoft torpedo tubes, all above water, two on each board-side, one astern.

There are besides, three electric flash-light projectors, two of 40 cm., one of 75.

Engines.—The two engines, absolutely similar to those of the Argentine *Garibaldi* are vertical and triple-expansion. They can each develope 6750 horse-power by forced draught, and give the vessel a speed of 19.6 knots.

The auxiliary engines, with a total of about 500 horse-power, comprise 6 engines for the electric lighting and the working of the turrets, the pumps, ventilators etc.

The normal supply of coal is 600 tons; but rises to 1200 tons if the auxiliary supply be included.

—*Le Yacht*, May 22, 1897.

BOOK REVIEWS.

Die Heere und Flotten der Gegenwart, herausgegeben von C. von Zepelin, K. Preuss. Generalmajor a. D. II. Grossbrittannien und Irland. Berlin: Schall & Grund. 15 Mark. Pp. 537.

This magnificent series appears at a time when all the world seems ready to plunge into war, and navies and armies are the talk of the day. The first volume presents an account of the army and navy of Germany; the present volume is devoted to Great Britain and Ireland.

The portion relating to the army is written by a Lieutenant-Colonel of the British General Staff, and is a most valuable and interesting production. The English army is unique in Europe, as England is practically the only one of the great nations that has been able to retain the system of voluntary enlistment, and has thus far avoided setting up a great standing army, like those of her neighbors on the Continent.

In a brief historical introduction the author traces the principal changes which have taken place from 1660 to the present time, and naturally explains incidentally the origin of the characteristic features of the present organization. The recruiting system, the composition and organization of the various branches of the army, including Militia, Yeomanry and Volunteers, are all described in detail, and with authoritative accuracy. Some of the special features of the organization are the mounted infantry (which England alone endorses), the machine gun sections, and the Army Service Corps. The two last mentioned subjects are especially worthy of study by us, because England has had considerable experience with machine guns in the Soudan, and the army service corps (or something similar) will be a great desideratum in our army in time of war.

The second part relates to the armament of the different branches of the army, and contains a brief résumé of the elementary tactics of the three arms, marches, outposts, systems of supply etc., all of which is set forth clearly and accurately, and with a completeness that is somewhat surprising, considering the small space into which it is condensed. The most noticeable feature to us is the gun pit: our light artillery drill-regulations contain a diagram of an English gun-pit which was new about twenty-five years ago, when Major Sanger brought it to our notice, but which (like all the others in our drill-regulations), have long since become obsolete.

The third part relates to the officers, non-commissioned officers and military schools.

This first portion of the volume, relating to the army, certainly gives a very full and accurate picture of the organization and composition of that body of men that has made its record glorious in all parts of the world, in language that is both entertaining and instructive, always clear and to the point, and without a superfluous word.

The portion relating to the navy is the work of the German Naval Captain A. Stenzel, and opens with a historical review of the growth of the world's greatest sea-power, which forms a most interesting chapter. The organization of the British Admiralty is then treated in detail, followed by an essay on the naval Policy of England and a description of the naval stations, docks etc., at

home and abroad. The personnel of the navy, officers and men, receives careful attention, and the work closes with a masterly description of the material of the navy, ships and guns, that traces its history from the middle of the seventeenth century to the present time.

The illustrations of the book are superb, and many of them are in colors: there are more than a hundred and twenty illustrations in all, and these, of course, add greatly to the value as well as the beauty of the volume. As a work of reference on the subject it is invaluable; there is an air of thoroughness and completeness about it that is very satisfactory to the reader, and the publishers and the authors may well be proud of the result of their labor.

J. P. W.

Aus Meinem Leben. Aufzeichnungen des Prinzen Kraft zu Hohenlohe-Ingelfingen. Vol. I. 1848-1856. Berlin: E. S. Mittler und Sohn. 1897. Pamphlet, 8 Marks; bound, 9.50.

Personal memoirs are always a welcome form of literary production, but particularly is this the case when they emanate from persons who have held high positions and have had experiences beyond the range of ordinary mortals. Prince Kraft zu Hohenlohe-Ingelfingen has done the world a great service in recording the experiences of his eventful life, and presenting them in the work of which the present volume is the introduction. According to the expressed wish of the Prince the publication of these memoirs was not begun until five years after his death, and they are now edited by Lieutenant-General Arved v. Teichman und Logischen.

The Prince's ability placed him at an early age in responsible positions, and led to his rapid advancement and the attainment of high rank; so that professionally his experiences were remarkable and interesting. Moreover, his selection as Adjutant by two monarchs gave him an opportunity of observing at close range the great political movements that swayed the nation. Combined with these exceptional advantages he possessed qualities which rendered the material more than ordinarily available to his land, for he was gifted with high literary attainments, with a keen power of observation and with an excellent judgment, so that he knew how to select his material and also how to present it in attractive and interesting form.

The work is not intended to be history, but personal memoirs in the truest sense, the object being to relate only personal experiences, and to present them with all the feeling and impression made on the author at the time of their occurrence.

The memoirs are preceded by a sketch of the author's life, written by the editor, which places before us the main features of the Prince's life, as well as the strong character of the man, and enables us to more fully grasp the significance of his own words.

The memoirs proper begin with the days preceding the revolution of 1848, when the Prince was already twenty years of age. The account of the feelings prevalent among the peasants in these exciting times is particularly interesting as he had exceptional opportunities for observation, not only officially, but privately, on his father's land, where the latter fed as many as fourteen hundred of his own men at his own cost to keep the deluded men from starving.

Being stationed in Berlin or Potsdam during the revolution he saw the most exciting part of the events there enacted, and gives us a graphic description of his experiences.

The author then takes up the record of the quiet events of ordinary garrison life, begining in 1849, in which many an amusing incident of his superior officers is recorded. In 1850 he entered the war school (*Kriegschule*), and of his life there he gives a most interesting account. In 1853 he returned to his regiment, and we have again some valuable sketches of character and life. His major happened to be Freiherr v. der Goltz, and we have a very delightful little sketch of him as he then was. The following year he was sent to Vienna as attaché, where he remained until 1856, when he was appointed Adjutant to his Majesty the King.

During his sojourn in Vienna he carefully studied the Austrian army, and also made a tour through Italy and studied there the armies as well as the historical battle-fields. Gun-cotton and the field telegraph appeared for the first time as factors in the art of war, in Austria at this time, and, of course, attracted the Prince's attention.

This first volume, therefore, has much of general interest, but, great as are the events recorded, they are as nothing compared to the events to come, in 1866, and in 1870—1.

The Prince is well known in the military world by his valuable and entertaining *Letters* on Strategy and on the three arms of the service, and all military students will be attracted to this new work of his, as much by their interest in the man, as by the intrinsic worth of his work.

The publishers have clothed the work in an appropriate dress, and paper and print are excellent.

J. P. W.

Naval Gunnery. Captain H. Garbett, R. N. The Macmillan Company, 66 5th Ave., New York. Price $1.50.

Great as has been the improvement in all things connected with ordnance and gunnery in the last quarter century there is as yet no appearance of finality. Every new gun, every new carriage and in fact every piece of material shows an improvement of some kind, hence no book on the subject can be quite up to date. On the other hand the field is so vast and broad that it cannot be exhaustively treated within moderate limits—therefore in treating the subject the author must bear in mind the particular object of his work and the particular class of readers which he expects to reach.

In this volume the author has set for himself the task of tracing the history of naval gunnery from the time when guns were first used aboard ships down to the present time; and showing the causes in the development of the modern battleship from the old wooden ship of the line.

The work is intended particularly for non-professional readers and the treatment is such that they will have no difficulty in following the author in his development of the subject.

Particular attention should be called to the chapter on the development of the modern battleship and to that on quick firing guns. In the former is shown clearly the varying position and thickness of the armor and distribution of the armament from the earliest ironclad to the present day. In the latter is treated the marvelous development of the quick firing system and its application to increasing calibers.

The illustrations, paper, and print are all excellent.

C. C. W.

Kriegsgeschichtliche Beispiele aus dem deutsch-französischen Kriege von 1870/71. Kunz, Major a. D. 3. und 4. Heft. E. S. Mittler und Sohn. 4.60 and 1.75 Marks, respectively.

This most excellent series of historical examples from the Franco-Prussian War is continued in two more numbers (3 and 4) concluding the subject of *Night Combats*. We know of no work that is so replete with valuable lessons taught by the great teacher, Experience, than this collection of historical incidents, and none that is so well worthy of careful study by all officers, whatever their rank. On the subject of night combats it stands without a rival, since no other work has ever treated this most important subject in so thorough a manner; but not alone is it valuable in an historical sense, for the separate combats, interesting as they are in their graphic presentation by the author, are made the texts of authoritative discussions on the general subjects involved in night combats, and their proper use in future wars, so that the work as a whole constitutes a text-book on this special, but highly essential and heretofore neglected, branch of tactics.

Number 3 describes 83 night combats, some in the north and north-west of France, others from the campaign on the Loire, and finally a number from General v. Werder's campaign in the south of France. Some idea of the probable importance of night combats in future wars may be derived from the author's statement that nearly all the battles and the more important combats of the war against the French Republic lasted until after dark, and many until far into the night. He found it impossible, therefore, to describe all combats of this character, and included only such as took place in the night, taking into consideration combats which ended in the night only when they presented characteristic features pertaining specially to night combats. This number, although somewhat larger than the preceding ones, loses nothing in interest, indeed, the reader of any one of the incidents described will have to acknowledge on laying aside the work that he has learned something new. The comments, of course, assist the understanding of the events, but also inculcate principles that may stand the student in good stead in the future. Finally, each number closes with a series of problems (110 in this number), which are intended to suggest matter for thought, to illustrate the principles discussed, and to assist the student in the application of these principles to various conditions that may arise in war. Some of these are for the Second Lieutenant, others for the field officer; all are suggestive and instructive.

Number 4 is devoted to night combats in the attack and defense of fortifications, and is, consequently, of special interest to the Artillery officer. The 32 illustrations and examples of night combats, which it describes, are taken from the sieges of Strassburg, Verdun, Belfort and Paris, and furnish rich material for reflection and study.

These two numbers, like the others of the series, are supplied with excellent separate maps and a number of sketches on a larger scale scattered through the text, so that in this respect they leave nothing to be desired.

In conclusion, we heartily recommend this work to military students, and look forward with much interest to the continuation of the series.

J. P. W.

The International Annual of Anthony's Photographic Bulletin and American Process Year Book for 1898. Edited by W. J. Scandlin. New York: E. & H. T. Anthony & Co. Pp. 303. $1.00.

No one could fail to be pleased with the fine appearance of this annual. Its

illustrations are excellent examples of the present high standard of American process work and the printer's art; while the contributed articles, many of which are by well known writers and workers in photography and photo-engraving, are upon subjects of interest to all photographic workers.

The many interesting points discussed and difficulties explained in these articles, should render it indispensable to those who are practically interested in these subjects.

The volume is made complete by an appendix containing valuable photographic and process formulae, some of which were, a few years ago, worth hundreds, or possibly thousands of dollars.

J. K. C.

Kriegstechnische Zeitschrift für Offiziere aller Waffen. Ten numbers per year 10 Marks ($2.50). Berlin: E. S. Mittler und Sohn.

This successor of the well-known publication entitled *Archiv für die Artillerie- und Ingenieur-Offiziere des deutschen Reichsheeres*, bids fair to keep up the standard set by its predecessor.

The first number has appeared and its contents speak for themselves:

1. Combustible blank cartridges, for use in small-arms, having the shape of the complete round (including bullet).
2. The modern field gun.
3. Military Ballooning: technical considerations.
4. Russian experiments in crossing streams by means of extemporised material.
5. Telegraphy without wires.

Professional Notes.

Book Reviews.

J. P. W.

Scientific American Supplement Reference Catalogue. New York: Munn & Co., 361 Broadway.

Messrs. Munn & Co. have issued an admirably arranged reference catalogue of the *Scientific American Supplement*, which should be of great use to students of scientific subjects. The importance of the articles may be judged by a few extracts:

Ordnance and armor. (46 principal references).

Mortars.—Construction of Modern Breech Loading Rifled Mortars.

Torpedoes and Torpedo Warfare. (15 principal references).

Brennan Torpedo.

Canet Torpedo Discharge Tube.

Defense of a Port by Torpedoes.

Torpedo Warfare.

Use of Torpedoes in war. E. P. Galway, R. N.

J. P. W.

BOOK NOTICES.

[These books will be fully *reviewed* as space becomes available.]

Der Kampf um Küstenbefestigungen, von Sigmund Mielichhofer, k. u. k. Hauptmann. Wien und Leipzig: Wilhelm Braumüller. 1897. 2 Mark.

Der Griechisch-Türkische Krieg des Jahres 1897. Nach officiellen Quellen von einem höheren Offizier. Berlin: Schall & Grund. 5 Mark.

Kriegsgschichtliche Beispiele aus dem deutsch-franzosischen Kriege von 1870-71. Von Kunz, Major a. D. Berlin: E. S. Mittler und Sohn. 1897.

Fünftes Heft: Attacken. 2 Mark.

Sechstes Heft: Feldartillerie. 1.60 Mark.

Siebentes Heft: Feldartillerie. 1.40 Mark.

Recueil des Travaux Techniques des Officiers du Génie de l'Armée Belge. I. 1897. Ixelles.

Preparatory Battle Formations. Major-General H. Bengough, C. B. London and Aldershot: Gale and Polden. 1 Shilling.

A method of measuring the pressure at any point on a structure, due to wind blowing against that structure. Francis E. Nipher. Transactions Academy of Science of St. Louis.

Artilharia de Campanha. Canhao Krupp de 7.5 *cm., L* 28. C. Leydecker. Rio de Janeiro: *Journal de Commercio.* 1897.

The History of our Navy, from its origin to the present day, 1775-1897. John R. Spears. Four volumes, with more than four hundred illustrations, maps and diagrams. New York: Charles Scribner's Sons. 1897.

INDEX TO CURRENT ARTILLERY LITERATURE.

PERIODICALS CITED.

Abbreviations employed in index are added here in brackets.

All the periodicals are preserved in the Artillery School Library, Fort Monroe, Virginia.

ENGLAND.

Aldershot Military Society. *Occasional.*
Aldershot. Copies 6*d each.*

Arms and Explosives. [*Arms and Ex.*] *Monthly.*
Effingham House, Arundel Street, Strand, London, W.C. Per year 7*s.*

Army and Navy Gazette. [*A. and N. Gaz.*] *Weekly.*
3 *York Street, Covent Garden, London. Per year* £1 12*s* 6*d.*

Canadian Military Gazette. [*Can. Gaz.*] *Fortnightly.*
Box 2179 *Montreal, Canada. Per year* $2.00.

The Engineer. [*Eng.*] *Weekly.*
33 *Norfolk Street, Strand, London. Per year* £2 6*d.*

Engineering. [*Eng'ing.*] *Weekly.*
35-36 *Bedford Street, Strand, London, W.C. Per year* £2 6*d.*

Journal of the Royal United Service Institution. [*Jour. R.U.S.I.*] *Monthly.*
17 *Great George Street, London, S.W. Per year* 24 *s.*

Journal of the United Service Institution of India. [*Jour. U.S.I. India*] *Quarterly.*
Simla, India. Per year $2.50.

Photographic Journal. [*Photo. Jour.*] *Monthly.*
12 *Hanover Square, London.*

Proceedings of the Institution of Civil Engineers. [*Proceedings I.C.E.*]
25 *Great George Street, Westminister, London.*

Proceedings of the Institution of Mechanical Engineers.
[*Proceedings I.M.E.*] 19 *Victoria Street, Westminister, London.*

Proceedings of the Royal Artillery Institution. [*Proceedings R.A.I.*] *Monthly.*
Woolwich, England.

Professional Papers of the Corps of Royal Engineers.
[*Prof. Papers Corps Royal Eng'rs.*]
Chatham, England.

Review of Reviews. [*Rev. of Rev. Austral.*] *Monthly.*
169 *Queen Street, Melbourne, Australia. Per year* 11 s. 6 d.

Transactions of the Canadian Institute. [*Trans. Canadian Inst.*]
58 *Richmond Street, Toronto, Canada.*

Transactions of the Canadian Society of Civil Engineers.
[*Trans. Canadian Soc. C.E.*]
Montreal, Canada.

Transactions of the East of Scotland Tactical Society.
[*Trans. E. of S. Tactical Soc.*]
51 *Hanover Street, Edinburgh, Scotland.*

Transactions of the Institute of Naval Architects.
[*Trans. Inst. Naval Architects.*]
5 *Adelphi Terrace, London, W.C.*

United Service Gazette. [*U. S. Gaz.*] *Weekly.*
4-6 *Catherine Street, Strand, London, W.C. Per year* £1 10*s* 6*d.*

FRANCE.

L'Avenir Militaire. [*Avenir.*] *Semi-weekly.*
13 *Quai Voltaire, Paris. Per year* 18 *Fr.*

Le Génie Civil. [*Génie C.*] *Weekly.*
6 *Rue de la Chaussée d'Antin, Paris. Per year* 45 *Fr.*

Journal des Sciences Militaires. [*Sciences Militaires.*] *Monthly.*
Rue et Passage Dauphine 30, *Paris. Per year* 40 *Fr.*

La Marine Française. [*Marine F.*] *Semi-monthly.*
23 *Rue Madame, Paris. Per year* 30 *Fr.*

Mémoires et Compte Rendu des Travaux de la Société des Ingénieurs Civils.
[*Ingénieurs Civils.*] *Monthly.*
10 *Cité Rougemont, Paris. Per year* 36 *Fr.*

Mémorial des Poudres et Salpêtres. [*M. Poudres et S.*] *Quarterly.*
Quai des Grands-Augustins, 55, *Paris. Per year* 12 *Fr.*

Le Monde Militaire. [*Monde.*] *Fortnightly.*
76 *Rue de Seine, Paris. Per year* 6 *Fr.*

Revue d'Artillerie. [*R. Artillerie.*] *Monthly.*
5 *Rue des Beaux-Arts, Paris. Per year* 22 *Fr.*

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Berger Levrault et Cie, Rue des Beaux-Arts 5, *Paris. Per year* 33 *Fr.*

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37 *Rue de Bellechasse, Paris. Per year* 27 *Fr.*

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8 *Rue Saint-Dominique, Paris. Per year* 27 *Fr.*

Revue d'Infanterie. [*R. Inf.*] *Monthly.*
11 *Place Saint André-des-Arts, Paris. Per year* 25 *Fr.*

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11 *Place Saint André-des-Arts, Paris. Per year* 25 *Fr.*

Le Yacht—Journal de la Marine. [*Yacht.*] *Weekly.*
55 *Rue de Chateaudun, Paris. Per year* 30 *Fr.*

GERMANY.

Allgemeine Militaer-Zeitung. [*A. M.-Zeitung.*] *Semi-weekly.*
Darmstadt. Per year 24 *M.*

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Beiheft zum Militaer-Wochenblatt. [*Beiheft.*]
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Deutsche Heeres-Zeitung. [*Heeres-Zeit.*] *Semi-weekly.*
Wilhelmstrasse 15, *Berlin. Per year* $6.00.

Internationale Revue. [*Int. Revue.*] *Monthly.*
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Rathenow, Germany. Per year $4.50.

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Militaer-Wochenblatt. [*Wochenblatt.*] *Semi-weekly.*
Koch Strasse, 68, *Berlin, S. W.* 12. *Per Year* 20 *M.*

Militärische Rundschau. [*Mil. Rundschau.*] *Occasional.*
Zuckschwerdt & Co., Leipzig. Per quarter 4.75 *M.*

Stahl und Eisen. [*Stahl u. Eisen.*] *Fortnightly.*
Schadenplatz 14, *Düsseldorf. Per year* $5.00.

Umschau, Die. [*Umschau.*] *Weekly.*
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AUSTRIA.

Mittheilungen ueber Gegenstaende des Artillerie und Genie-Wesens.
[*Mitth. Art. u. G.*] *Monthly.*
Wien, VI, Getreidemarkt 9. *Per year* 1 *Fl.* 50 *Kr.*

Mittheilungen aus dem Gebiete des Seewesens. [*Seewesens.*] *Monthly.*
Pola. Per year 14 *M.*

Organ der Militaer Wissenchaftlichen Vereine. [*Vereine.*]
Wien I, Stauchgasse No. 4. *Per year*, 8-14 *numbers*, 6 *Fl.*

Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines.
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SWITZERLAND AND BELGIUM.

Allgemeine Schweizerische Militaer-Zeitung. [*A.S.M. Zeitung.*] *Weekly.*
Basel, Switzerland. Per year, 8 *Fr.*

La Belgique Militaire. [*Belgique M.*] *Weekly.*
Rue St. Georges 32, *Ixelles, Belgium. Per year* 12.50 *Fr.*

Monatschrift fuer Offiziere Aller Waffen. [*Monatschr.*] *Monthly.*
Frauenfeld, Switzerland. Per year 5 *Fr., plus postage.*

Revue de l'Armée Belge. [*A. Belge.*] *Bi-monthly.*
22 *Rue des Guillemins, Liège, Belgium. Per year* 13 *Fr.*

Revue Militaire Suisse. [*R. M. Suisse.*] *Monthly.*
Escalier-du-Marché, Lausanne, Switzerland. Per year 10 *Fr.*

Schweizerische Zeitschrift fuer Artillerie und Genie. [*S. Zeitschrift.*] *Monthly.*
Frauenfeld, Switzerland. Per year 8 *Fr.* 20 *centimes.*

SPAIN, PORTUGAL AND SOUTH AMERICA.

Boletin del Centro Naval. [*Boletin.*] *Monthly.*
438 *Alsina, Buenos Aires, Argentina Republica. Per year* $11.00.

Circulo Naval,—Revista de Marina. [*R. de Marina.*] *Monthly.*
Casilla num. 852, *Valparaiso, Chili.*

Memorial de Artilleria. [*M. de Art.*] *Monthly.*
Farmacia, num. 13, *Madrid, Spain. Per year, U. S.,* $3.40.

El Porvenir Militar. [*Porvenir.*] *Weekly.*
258 *Calle Montevideo, Buenos Aires, Argentina. Per year* 10 $ $\frac{m}{n}$.

La Prensa Militar. [*Prensa.*] *Weekly.*
Reconquista 1034, *Buenos Aires, Argentina.*

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5 *Calle de Cervantes, Barcelona, Spain. Per year* 32 *Fr.*

Revista da Commissao Technica Militar Consultiva. [*R. da Commissao.*] *Bi-monthly. Praça da Republica N.* 32, *Rio de Janeiro, Brazil.*

Revista de Engenheria Militar. [*Engenheria Mil.*] *Monthly.*
27 *Rua Nova do Almada, Lisbon, Portugal. Per year* 1 $ 800 *réis.*

Revista do Exercito e da Armada. [*Exercito.*] *Monthly.*
Largo de S. Domingos No. 11, *Lisbon, Portugal. Per year U. S.* $6.00.

Revista General de Marina, [*R. G. de Marina.*] *Monthly.*
56 *Calle de Alcalá, Madrid, Spain. Price U. S.* $4.45.

Revista Maritima Brazileira. [*R.M. Brazil.*] *Bi-monthly.*
Rue do Conseheiro Saraiva n. 12, *Rio de Janeiro, Brazil. Per year* $10.00.

Revista Militar. [*R. Mil. Portugal.*] *Semi-monthly.*
262 *Rua da Princeza, Lisbon, Portugal. Per year,* $2.60.

Revista Militar. [*R. Mil. Chile.*] *Monthly.*
Santiago, Chili.

HOLLAND AND SCANDINAVIA.

Artillerie-Tidskrift. [*Art. Tids.*] *Bi-monthly.*
Stockholm, Sweden. Per year, U. S., $1.75.

De Militaert Gids. [*M. Gids.*] *Bi-monthly.*
De Erven F. Bohn, Haarlem, Holland. Per year, U. S., $2.00.

Militaert Tidsskrift. [*M. Tids.*] *Bi-monthly.*
Copenhagen, Denmark. Per year, U. S., $2.50.

Norsk Militeert Tidsskrift. [*N. M. Tids.*] *Monthly.*
Christiania, Norway. Per year, U. S., $2.50.

RUSSIA.

Artilleriiskii Journal. [*Art. Journal.*] *Monthly.*
Furschtatskaia Ulitza, St. Petersburg, Russia.

Razviedchik. [*Razv.*]
KoloKolwaia Ulitza, No. 14, *St. Petersburg, Russia.*

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ITALY.

Rivista di Artiglieria é Genio. [*R. Artig.*] *Monthly.*
Tipografia Voghera Enrico, Rome. Per year 30 *L.*

Rivista Marittima. [*R. Maritt.*] *Monthly.*
Rome. Per year 25 *L.*

UNITED STATES.

American Engineer and Railroad Journal. [*Eng. and Rail. Jour.*] *Monthly.*
47 *Cedar Street, New York City. Per year* $3.00.

American Journal of Mathematics. [*Jour. Math.*]
John Hopkins University, Baltimore, Md.

American Machinist. [*Amer. Mach.*] *Weekly.*
256 *Broadway, New York City. Per year* $3.00.

American Manufacturer and Iron World. [*Man. and Iron World.*] *Weekly.*
59 *Ninth Street, Pittsburgh, Pa. Per year* $4.00.

Annual of the Office of Naval Intelligence. [*Naval Intelligence.*]
Washington, D. C.

Army and Navy Journal. [*A. and N. J.*] *Weekly.*
New York City. Per year $6.00.

Army and Navy Register. [*A. and N. R.*] *Weekly.*
Washington, D. C. Per year $3.00.

Bulletin of the American Mathematical Society. [*Bulletin Math. Soc.*]
University Heights, New York City.

Cassier's Magazine. [*Cas. Mag.*] *Monthly.*
World Building, New York City. Per year $3.00.

Digest of Physical Tests. [*Digest.*] *Quarterly.*
1424 *N. 9th Street, Philadelphia. Per year* $1.00.

Electrical Engineer. [*Elec. Eng.*] *Weekly.*
203 *Broadway, New York City. Per year* $3.00.

Electrical Engineering. [*Elec. Eng'ing.*] *Semi-Monthly.*
443 *The Rookery, Chicago, Ill. Per year* $1.00.

Electrical Review. [*Elec. Rev. N. Y.*] *Weekly.*
41 *Park Row, New York City. Per Year* $3.00.

The Engineer. [*Eng. N. Y.*] *Fortnightly.*
106-108 *Fulton Street, New York City. Per year* $2.50.

Engineering Magazine. [*Eng'ing. Mag.*] *Monthly.*
120-122 *Liberty Street, New York City. Per year* $3.00.

Engineering News and American Railroad Journal.
[*Eng'ing News and R.R. Jour.*] *Weekly.*
220 *Broadway, New York City. Per year* $5.00.

Engineering and Mining Journal. [*Eng. and Min. Jour.*] *Weekly.*
253 *Broadway, New York City. Per year* $5.00.

The Iron Age. [*Iron Age.*] *Weekly.*
96-102 *Reade Street, New York City. Per year* $4.50.

Journal of Electricity. [*Jour. Elec.*] *Monthly.*
421 *Market Street, San Francisco, Cal.*

Journal of the American Chemical Society. [*J. Chem. S.*] *Monthly.*
Easton, Pa. Per year $5.00.

Journal American Society of Naval Engineers. [*A.S.N. Egrs.*] *Quarterly.*
Navy Department, Washington, D. C.

Journal of the Association of Engineering Societies. [*Eng. Soc.*] *Monthly*
257 *South Fourth Street, Philadelphia. Per year* $3.00.

Journal of the Franklin Institute. [*Frank. Inst.*] *Monthly.*
Philadelphia, Pa., Per year $5.00.

Journal of the Military Service Institution. [*Jour. M. S. I.*] *Bi-monthly.*
Governor's Island, New York City. Per year $4.00.

Journal of the U.S. Cavalry Association. [*Jour. U. S. Cavalry*] *Quarterly.*
Fort Leavenworth, Kansas.

Journal of the Western Society of Engineers. [*W. Soc. Eng.*] *Bi-monthly.*
1737 *Monadnock Block, Chicago, Illinois. Per year* $2.00.

Marine Review. [*Mar. Rev.*] *Weekly.*
Cleveland, Ohio. Per year $2.00.

Military Information Division. [*Mil. Information Div.*] *Occasional.*
War Department, Washington, D. C.

Notes on Naval Progress. [*Naval Intelligence.*] *Occasional.*
Navy Department, Washington, D. C.

Pennsylvania Magazine of History and Biography. [*Penn. Mag. of Hist.*] *Quarterly.*
13 *Locust Street, Philadelphia. Per year* $3.00.

The Photographic Times. [*Phot. Times.*] *Weekly.*
60 *and* 62 *E.* 11*th Street, New York City. Per year* $5.00.

Physical Review. [*Phys. Rev.*] *Bi-monthly.*
Cornell University, Ithaca, New York. Per year $3.00.

Popular Science Monthly. [*Pop. Sc. Mo.*] *Monthly.*
72 *Fifth Avenue, New York City. Per year* $5.00.

Proceedings of the American Philosophical Society. [*Proceedings of A. Phil. Soc.*]
104 *South Fifth Street, Philadelphia, Pa.*

Proceedings of the U. S. Naval Institute. [*Naval Inst.*] *Quarterly.*
Annapolis, Md. Per year $3.50.

Public Opinion. [*Pub. Opin.*] *Weekly.*
New York City. Per year $2.50.

Review of Reviews. *Monthly.*
13 *Astor Place, New York City. Per year* $2.50.

The Scientific American. [*Scien. Amer.*] *Weekly.*
361 *Broadway, New York City. Per year* $3.00.

Shooting and Fishing. *Weekly.*
293 *Broadway, New York City. Per year* $3.50.

Technology Quarterly. [*Tech. Quart.*] *Quarterly.*
Mass. Inst. of Tech., Boston, Mass. Per year, $3.00.

Transactions American Institute of Electrical Engineers.
[*Inst. Elec. Eng'rs.*] *Monthly.*
26 *Cortlandt Street, New York City. Per year* $5.00.

Transactions American Institute of Mining Engineers.
[*Trans. Inst. Min. Eng'rs.*]
P. O. Box 225, *New York City.*

Transactions of the American Society of Civil Engineers.
[*Trans. A. S. Civil Eng'rs*]
127 *East* 23*d Street, New York City.*

Transactions of the American Society of Mechanical Engineers.
[*Trans. A. S. Mech. Eng'rs.*]
12 *West* 31*st Street, New York City.*

Transactions of the Society of Naval Architects and Marine Engineers.
[*Naval Architects and Marine Eng'rs.*]
12 *West* 31*st Street, New York City.*

Western Electrician. [*West. Elec.*] *Weekly.*
510 *Marquette Building, Chicago, Illinois. Per year* $3.00.

Wilson's Photographic Magazine. [*Phot. Mag.*] *Monthly.*
853 *Broadway, New York City. Per year* $3.00.

ORGANIZATION AND ADMINISTRATION.

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PACK SADDLES AND A POWERFUL MOUNTAIN GUN.

With the use of pack animals the variety of packing gear is very great, but the nature of the country to be traversed, of the load to be transported, and in the mountain artillery especially the skill of the soldier as packers, will in a great measure determine the form and adjustment of the gear.

The most important part of the packing gear is the saddle, and in its construction two general methods are followed; one represented by the crude *aparajo*, and the other by the ordinary saddle.

The former are cumbrous, complicated as to gear, heavy in weight, and certain to produce sore backs and disabled mules unless in the hands of skillful packers, even when provided with extra appliances which add to the objectionable weight. The advantages which are claimed for the *aparajo*, are its shape which enables all loads to be balanced, (which has no bearing for mountain artillery material, where all loads balance naturally, as the guns, carriage, wheels, etc., or are carefully constructed to do so, as the ammunition boxes, etc.). It presents much more surface for pressure to the mule, than does any other form of pack saddle. One of our present pack saddles (that for ammunition) very perfectly illustrates the value of this claim. It was constructed under the supervision of one of the oldest and most experienced chief packers connected with the army, and due advantage was taken for the ample "surface for pressure on the mule."

When this saddle was taken into the field during the Pine Ridge campaign, the same chief packer was compelled by that experience to report that * * * "the ammunition pack disabled all the mules that were used with the full load of seventy-two rounds," the reason seemed plain, that the load was carried too low, with three boxes on each side, and brought too great a total pressure on the vital parts of the mule. (Report of Chief of

Ordnance 1892, p. 326). As a matter of fact the muscular construction of the mule or horse ridgidly limits the amount of surface available for the support of a load, and when this is exceeded the saddle is ruined.

The virtues claimed for this form of saddle being summarily disposed of as non-existant so far as applied to the mountain artillery material, there remains only the baggage to be considered, with which, when properly constructed, it may be used to advantage. For this purpose it would be hard to improve on the regular Quartermaster pack saddle, which, with its harness, etc., complete, weighs only forty pounds.

The other general principle upon which pack saddles are constructed and under which nearly if not all foreign pack saddles for the transportation of mountain artillery material are constructed, is that of the ordinary riding saddle, especially as represented by the cavalry saddle in use in any given army.

All cavalry saddles are designed to carry heavy weights, and the nature of these weights is such that it is impossible to distribute it in such a manner as to form a good pack, as respects their front and rear position, though well balanced from side to side. As in nearly all good mountain artillery pack saddles, the construction is based upon that of the cavalry saddle, it will be well to give some consideration to this saddle, its condition and use, and its construction, as the basis of a good pack saddle.

To begin with, the under surface of the saddle—the part coming in contact with the horse's back—we find two principal points of consideration: its shape and its size. As regards shape, the under surface of the saddle should bear as nearly as possible the same relation to that part of the horse's back it is intended to occupy as a mould does to the cast that is taken from it, always excepting the strip lying over the horse's back-bone, which must remain altogether out of contact. As regards the size or extent of the surface of contact, the greater this is with a given weight, the less will be the pressure at any given point, and consequently the less risk of a sore back or other injury to the animal, provided always that the pressure be equally distributed over the whole surface, and the surface be ridgedly confined to that which nature has made suitable to bearing burdens. This latter consideration at once limits the size of the saddle, due to the muscular construction of the animal, and to the further fact that its own weight is a matter for serious consideration; its weight must be deducted from the load carried, and any increase at once reduces the "useful" load carried.

There are two ways in which the weight of the saddle may be distributed without its useful *under* surface being contracted. The first is to avoid extending the frame or tree, or indeed any part of the saddle, beyond the surface where the pressure ought to be supported, and this being exercised in a perpendicular direction downward, it is not only useless but absurd to make these extend too far *down over the ribs latterly*. The second is to use materials combining great strength and moderate elasticity with the least possible weight.

An inspection of a plate illustrating the muscular development of the animal, will reveal a great, broad, flat muscle along either side of the back-bone, joining the fore and hind quarters, forming the suspension bridge upon which the saddle, which carries the load, must exclusively rest. The size and shape of these great tendons at once determine the size and shape of the side bars of our cavalry saddle. These bars do not extend beyond these muscles and bear upon the ribs extending beyond them.

The side bars should be as wide as possible—the full width of the muscle to its outer limit—and also as long as possible without receiving any of the muscular action of the fore and hind quarters. The angle which they make with each other must be fixed to suit the average animal of the class purchased for the service, when in the average good condition.

The average load carried by our cavalry horse is about two hundred and fifty-five pounds, including the saddle, etc. Now let it be supposed that this weight constitutes a mountain gun to be carried by the horse, the cavalry saddle to be converted into the necessary pack saddle, for its transportation, as is done in European armies. Manifestedly the bearing surface of the saddles must practically remain the same in all respects, though the side bars and their connection should be made stronger and provided with the necessary yokes front and rear, to support the gun. The weight of the pommel, cantel, stirrups, etc., would probably be ample to insure the necessary changes of this character, with from 5.6 to 7.1 pounds of good steel for the construction of good supports for the gun, or carriage, etc., to which must be added the usual pack saddle harness, when we would have the total weight of the resultant pack saddle, without its fitness for proper carrying of the usulal load on the horse's back having been changed in any respect, save that the added crupper render it more secure in its position when the animal travels over a rough and mountainous trail.

Saddle tree (U. S. Cavalry)	weight		17.30 pounds
Extra ironing	"	5.60 to	7.10 pounds
Different cincha and latigo	"		6.00 pounds
Crupper	"		2.75 pounds
Lashing girth and rope	"		3.50 pounds
Corona, canvass lined	"		3.50 pounds
Halter, or hackamore	"		2.60 pounds
Pack saddle, complete	"	45.55 to	47.05 pounds

As a practical fact of no little interest it may here be stated that the old pack saddle for our twelve pounder mountain gun weighed, complete, forty-seven pounds. It was an efficient and suitable pack saddle, and there is no apparent reason why, with modern steel, and methods of construction, that weight cannot be reduced without in any wise impairing the efficiency of the pack saddle.

It is probable that the blanket should be discarded and the under surface of the side bars padded, to be used over a properly made corona, which should be colored red, and marked with the battery designation, etc.

Padded saddles are decidedly objectionable to the professional packer because he has not a harness maker at command. But this objection has little or no force in the mountain battery. If the blanket be retained, then the under side of the side bars should have sheep skin secured to it, to prevent the blanket from slipping.

The Quartermaster pack saddle, provided with proper arches and springs to hold the ammunition boxes and with harness complete, would weigh not more than forty-three pounds. When used for baggage, etc., its weight is forty pounds.

The field artillery should be provided with a mountain gun of the same type as that for horse artillery, and firing the same projectiles. But if the latter gun is of the socalled quick fire pattern, most certainly a mountain gun should not be so. Any modern field gun with a caliber and weight of shrapnel to in any wise entitle it to the name, can, so far as rapidity of fire alone is concerned, fire altogether too rapidly for the limited supply of ammunition which it is possible to take into the field in war, and this restriction is far greater for a mountain gun under the conditions of pack service.

For such a gun, with the maximum weight of shrapnel, "fixed" ammunition is quite out of the question for many cogent reasons not necessary to mention, one alone being sufficient: the weight

of brass cartridge cannot be carried by a reasonable number of pack mules.

Assuming that a fifteen pound schrapnel is to be used in the three inch gun under comtemplation, a round would weigh about sixteen pounds, and with a twenty-four pound box, and five pounds for primers, implements, etc., a packed box with six rounds would weigh one hundred and twenty-five pounds. The old U. S. twelve pounder box with the same number of rounds weighed, packed, one hundred and twelve pounds, box twenty.

To fire a fifteen pound projectile with the velocity usual in modern mountain guns, will require a proportional weight of gun and carriage to "stand-up" behind the resultant muzzle energy. In order to secure this necessary weight, it would seem that the best means would be that employed by the English artillery with their so-catled "jointed" gun.

For the ordinary type of mountain gun, not intended to keep pace with cavalry commands on long and rapid marches, a load of three hundred pounds may be considered reasonable, when suitable and first class pack mules are provided.

No provision should be made for wheel transportation which would entail a long and heavy axle which, in the carriage cited below, would have to be unshipped and carried on an extra mule together with the shafts, harness, etc. Of the nearly two hundred mules in a battery at a war strength, not one tenth would derive any benefit from this devise. In the English mountain artillery drill, 1891, p. 89: "Mule Draught *(sic)*. It may often be found convenient and more expeditious, in ordinary changes of front in action, and for advancing and retiring short distances, when the ground is suitable, to move by *draught* instead of *limbering up*. The simple method detailed below is devised to meet the above purposes *only, as most mountain artillery authorities are of an opinton that the mountain artillery loose their greatest values as soon as they leave the 'pack system' for that of 'draught'*"—the italics are mine. The draft above mentioned for maneuvring purposes only, is to hitch two mules to the front of a gun carriage by improvised drag ropes and by aid of a special chain; no shaft and harness are found with the battery.

With the pack saddle indicated for a jointed gun we can have:

1st Animal	Pack saddle and harness	50 pounds
	Gun chase	230 pounds
	Equipment, etc.	15 pounds
		295 pounds

2nd Animal	Pack saddle and harness	50 pounds
	Gun breech	230 pounds
	Equipment, etc.	15 pounds
		295 pounds
3rd Animal	Pack saddle and harness	47 pounds
	Carriage body	235 pounds
		282 pounds
4th Animal	Pack saddle and harness	47 pounds
	Two wheels	220 pounds
	Equipment, etc.	15 pounds
		282 pounds
5th Animal	Pack saddle and harness	43 pounds
	Two ammunition boxes, packed	250 pounds
		293 pounds
Baggage Mule	Q.M. Pack saddle and harness	40 pounds
	Baggage	255 pounds
		295 pounds

The load has been taken as 295 pounds to allow five pounds for contingencies of construction, etc. The carriage and wheel packs are, from their nature, both bad packs. The loads for each are thirteen pounds less than for the other packs, and it would be better if the difference were still greater. But the necessity for as much weight as possible is imperative, and relief for the mule when necessary if the work is great, is found in the use of the spare mules which must be provided in every battery.

This would give us as the weight available for standing up behind a fifteen pound projectile when the gun is fired:

Gun		460 pounds
Carriage		235 pounds
Two wheels		220 pounds
	Total	915 pounds

The English gun, caliber 2.5, firing a 7.37 projectile with 1440 f.s. and 107 f.t.M.E. weighs without equipments, implements, etc., 924 pounds, or 8.63 pounds weight for each foot ton of muzzle energy. The Hotchkiss 3.00 inch gun weighs 548 pounds, with a 12 pound projectile, 840 f. s., and 59 f. t. M. E., or 9.3 pounds per ton of M. E.

To be on the safe side and certain of not too great recoil, with the latter measure we can have 98 f. t. for a fifteen pound projectile, this gives 970 f. s. Greater than this velocity we do not desire for a mountain gun, as at about this velocity the law of atmospheric resistance changes from the third to the fifth power, and any material increase in the muzzle velocity, while greatly increasing the muzzle energy and consequent recoil, would not materially increase the remaining velocity at battle ranges.

Such a gun would be greatly superior to the English gun, and in fact would have no superior among mountain guns; at the same time if we adhere to the fixed axle, we would have one mule less for the transportation of the gun, carriage, etc., than is required for the English gun.

Ninety-six rounds can be carried on eight mules, which is entirely satisfactory as compared with foreign batteries, and especially so when the weight of the shrapnel is considered.

There can be no question as to the stability of the carriage, as there is ample weight to insure a strong axle, when it is of minimum length. As the gun is heavier than the carriage its inertia will conserve the latter.

The muzzle section of the gun should not exceed 45 inches and the breech section about 26 inches in length.

The ordinary screw joint of the English gun has proved serviceable and satisfactory, though a better one might possibly be found in the use of some form of breech mechanism, as the slotted screw, with a slight conical taper to insure easy withdrawal.

With smokeless powder in cartridges, protected from moisture in some simple manner, it is quite evident that with a slight modification of the Quartermaster pack saddle, a fifteen pound projectile is entirely practicable in so far as regards a proper pack load. But it is also evident that it is impossible to secure a sufficient velocity for such a weight of projectile, without doubling the weight of the ordinary mountain gun, as has been done in the English service with such satisfactory results. Each section of the gun as above weighs 230 pounds, the French 3.15 inch gun weighs 231. The sections of the English gun weigh 200 pounds each, but this weight increased by 30 pounds would make very little difference to the cannoneers in the handling of the gun in sections, or as a whole.

A gun such as has been indicated would be much more powerful and efficient than was our old three inch M.L. Rifle in its day, which is saying not a little.

Even hampered to some extent by the use of their jointed gun,

the English mountain batteries in India have always been the peers of any in "smartness" and efficiency, though it must be conferred that the weight of the material is excessive, requiring a complete set of "relief" mules for its gun and carriage, etc., with 179 men, 100 native muleteers (hired), eight horses, and one hundred and ninety-six (196) mules.

If we should have to go to Cuba, mountain batteries would be necessary almost if not quite exclusively, and no mountain gun has been produced which could in any wise compare with that here indicated, even though the system fall very far short of what has been indicated above.

A. D. SCHENCK,
Captain, Second Artillery.

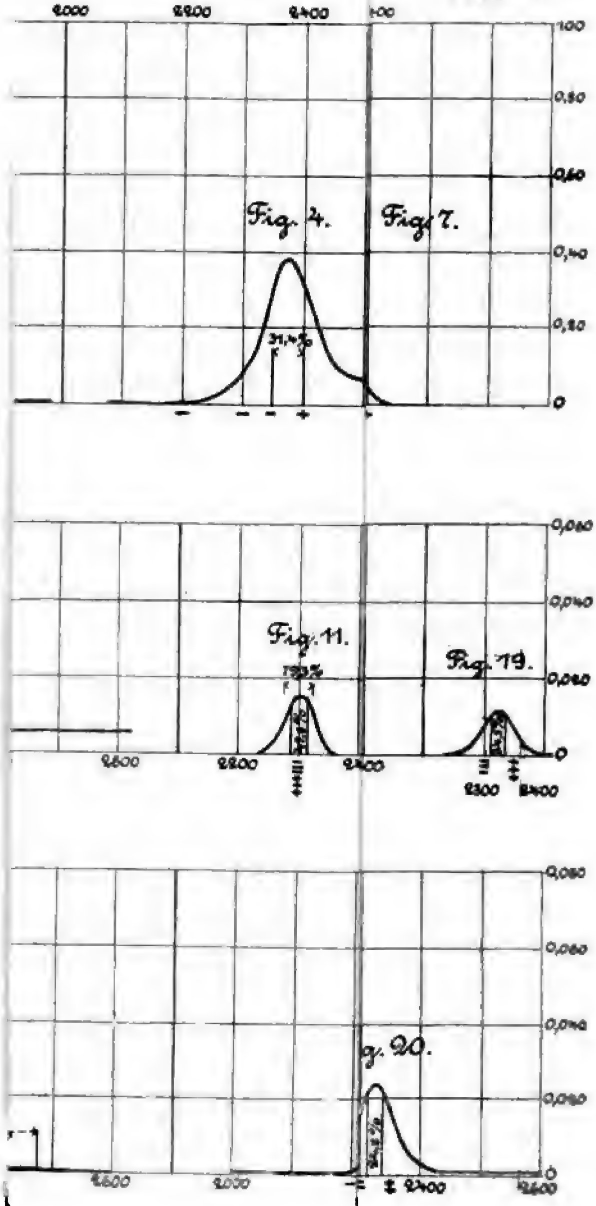
NOTE TO PLATE II.

In all figures the abscissas denote the distances from the target, or from the mean points of impact, to the gun. The ordinates give the probability that the target stands at the distance corresponding thereto, if the shots fired at the several distances denoted by — or + (in front or in rear of the target) were observed as these attached signs indicate.

The probability that the target stands between any two distances will be expressed by the ratio of the area included by the corresponding ordinates and the curve, and the entire area bounded by the curve. (Compare in Fig. 1 the shaded portion.)

The numbers written in the diagrams give the probability expressed in per cent.

Tafel II.



v. Ol. Keller, Berlin S.

CONCERNING THE RELIABILITY OF RANGE-FINDING SHOTS.

By ROHNE, Lieutenant-General and Governor of Thorn.

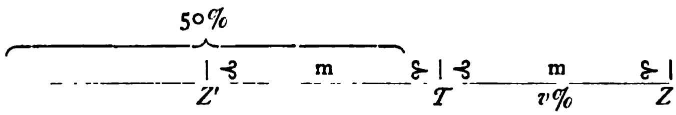
The author of the present study addresses not so much the company officers, as those officers, who by their positions at the Shooting School, the Artillery School, or the Artillery Proving Commission, are detailed to work at the practical and theoretical development of the art of shooting. In this, the present work, we are to submit to proof the reliability of the trial shots, and to investigate whether the observance of the target practice book offers a sufficient guarantee that we are to receive with quick certainty an ample effect; or whether we are able to alter the operations of shooting to secure this object. Deep mathematical knowledge is not essential to this undertaking; a certain intimacy with logarithmic calculation, and a knowledge of the most elementary principles of probabilities, are sufficient.*

As is well known, all rules for shooting prescribe that the target shall first be brought into a fork by two shots— a short and an over shot—this fork by being divided gradually contracts, and so the distance of the target will be approximately ascertained. If there were no "*scattering*" (Streuung) we should be able by continual bisection of the fork to carry out our range-finding very quickly to any desired degree of accuracy. The 'scattering' is but one cause of wrong fork constructions; that is to say, the target itself may not be between the two limiting distances; although determined by one shot in front and one in rear, it may nevertheless be found outside these distances. If, for example, a shot fired with the elevation for 2000 m. is in front of the target, and one with the elevation for 2100 m. is in rear of it, the target may still be nearer than 2000 m. or farther away than 2100 m., because the shot with an elevation for 2000 m. may be accidentally a short shot, or that with an elevation for 2100 m. accidentally an over shot. Only by the delivery of a number of shots with the

* The suggestion of the following work, I owe to the very concise exposition (A'propos du jeu de tir), which is published by Captain Magnon in the *Revue de L'Armée Belge* (1896, July-August). This work supplementing mine in the second part of the "Artillery Fire Game," applies to the consideration of the reliability of fork building, and verifies my deductions in a satisfactory manner—that which is entirely new and interesting in this work, is its strict scientific examination of the question; with what certainty can we draw our conclusions as to the definite position of the target, from the observation of any shot? The method is here repeated.

same elevation, can we aquire accurately the true location of the target.

It is evident that the number of short and over shots bears an entirely definite ratio to the extent of the "*spread*" (Streuung) and the location of the mean point of impact with reference to the target; which ratio may be determined by means of the Theory of Probabilities. If the firing, for example, is at 2000 m. with an elevation proven to be correct for the conditions, one half of all the shots should fall in front, the other half in rear of the line across the range at 2000 m. If the firing, on the other hand, is somewhat too short, that is to say, if the mean point of impact falls in front of this line, we shall receive more shots in front and fewer in rear of the line.



If the mean point of impact, T, falls at the distance m in front of the target Z, it is easy to calculate the number of projectiles which will found in the enclosed space TZ. The space ZZ', twice TZ, $=$ 2 m. If s is the mean "*spread*," (Streuung) $\frac{2\text{ m}}{s}$ is the probability factor, and it enables us to read off at once from the known table of probability factors the number denoting the % of "hits" which fall in this space. Then in the space TZ falls half of these hits. If the % of hits which fall in the space TZ is represented by the number v, of every 100 shots we shall have $50 + v$ short shots; because half of all shots lie on this side of the mean point of impact T.

Example.—How many short shots do we get at 2000 m. when the mean point of impact lies 20 m. in front of the target?

1. Under the supposition of a mean spread as set down in the range table (i. e. mean spread of 23 m)., and

2. Under the supposition of a mean spread of 50 m.

In this case m is equal to 20, s equals 23 (or 50). The probability factor will therefore be $\frac{40}{23} = 1.74$ (or $\frac{40}{50} = 0.80$). This factor corresponds, according to the table, to 76 % (or 41 %) of hits. We get, consequently, $50 + 38 = 88$ % (or $50 + 20.5 = 70.5$ %) of short shots.

We thus have for every position of the mean point of impact with reference to the target, expressed by the relation to the mean spread, an entirely definite per cent of short or over shots.

The amount of the mean spread is not known in the shooting—it depends upon many contingencies, new ones arising at every shot; and it changes continually, even during the course of the firing. As is well known, the deductions of the range table are made under favorable circumstances; they apply also only to one particular gun. In the firing by the battery, under service conditions, the numbers of the range table should, at least, be doubled, so that the proper fighting ranges of about 3500 m. could be estimated to within about 50 m. In cases of great accuracy, as in our investigation, the range table will not answer at all.

The following compilation (Table I) shows, for the various positions of the mean point of impact with reference to the target, the percent of all shots fired, which we may probably expect to find as short or as over shots; or, what is the same thing, it shows the probability of getting a short or an over shot.

For reasons which will appear later the logarithm of this ratio figure is placed opposite its number.

TABLE I.

1	2	3	4	5	6
Position of the mean point of impact with reference to the target.		Probability p, of a short shot.	log p *	Probability q, of an over shot.	log q *
Mean spread (s)	m				
— 3	— 150	1.0	10.0	0	
— 2.75	— 137.5	0.9999	9.999	0.0001	6.000
— 2.5	— 125	0.9996	9.999	0.0004	6.602
— 2.25	— 112.5	0.9988	9.999	0.0012	7.079
— 2.0	— 100	0.9965	9.998	0.0035	7.544
— 1.75	— 87.5	0.9909	9.996	0.0091	7.959
— 1.5	— 75	0.9785	9.990	0.0215	8.332
— 1.25	— 62.5	0.954	9.979	0.046	8.663
— 1.0	— 50	0.911	9.959	0.089	8.949
— 0.75	— 37,5	0.844	9.926	0.156	9.193
— 0.5	— 25	0.750	9.875	0.250	9.398
— 0.25	— 12.5	0.632	9.801	0.368	9.566
∓ 0	∓ 0	0.50	9.699	0.50	9.699
+ 0.25	+ 12.5	0.368	9.566	0.632	9.801
+ 0.5	+ 25	0.250	9.398	0.750	9.875
+ 0.75	+ 37.5	0.156	9.193	0.844	9.926
+ 1.0	+ 50	0.089	8.949	0.911	9.959
+ 1.25	+ 62.5	0.046	8.663	0.954	9.979
+ 1.5	+ 75	0.0215	8.332	0.9785	9.990
+ 1.75	+ 87.5	0.0091	7.959	0.9909	9.996
+ 2.0	+ 100	0.0035	7.544	0.9965	9.998
+ 2.25	+ 112.5	0.0012	7.079	0.9988	9.999
+ 2.5	+ 125	0.0004	6.602	0.9996	9.999
+ 2.75	+ 137.5	0.0001	6.000	0.9999	9.999
+ 3.0	+ 150	0.0000	—	1.000	10.000

* To complete the logarithm, subtract 10.

This table is also to be used for every other amount of mean spread; column two being made to correspond to the change. If, for example, the mean spread is not 50 but only 25 m., all the numbers in column two would become one half of what is here set down; on the other hand, they would be doubled if the mean spread were 100 m.

To illustrate—if the mean point of impact lies 25 m. in front of the target, we shall have, according to the table, 750 of every 1000 shots in front, and 250 in rear of the target. We should get this same ratio by perfectly accurate observation of the shots. Experience teaches, however, that not every shot will be correctly observed; a part will be incorrectly observed, and many more will be of questionable accuracy. In my book appearing in 1881 —"The Firing of Field Artillery"—I stated that according to the list prepared by me at the Artillery Shooting School, 62 shots of every 100 used in the construction of the fork will be correctly, and 7 incorrectly observed, while 31 will be of questionable correctness. Since the questionable shots probable detract from the success of the trial shots, at least sufficing to make the work uncertain, they must be entirely left out of consideration; there remains then 1 incorrect to 9 correctly observed shots. [62 to 7.] This ratio was, during the time of black powders, subject to only small fluctuation; how it varies when using the smokeless powders, I have not been able to ascertain. On the one side, the observation is made easier by reason of the falling away of the smoke; but on the other, it has become more difficult, on account of being less easily distinguished from objects in the landscape.

Our extended investigation will be on the ground of the ratio of 1 shot incorrectly, to 9 shots correctly observed. Then each one can easily form for himself an idea as to how the results will be changed, due to more favorable or to less favorable observation. We make also the additional supposition, not exactly corresponding to the actual circumstances, that the trustworthiness of the observation shall be independent of the distance of the point of impact from the target. It appears that the observation of shots falling close in front or in rear of the target (always remembering that the wind may carry the smoke of a projectile falling close in front of the target, to the rear of the target, and vice versa) will be more difficult and less reliable than that of shots which fall at some considerable distance in front or in rear of the target. It is entirely possible that in the observation of those shots falling very near the target, we may get one incorrect to five correct observations; while of the shots falling,

say, 200 m. in front or in rear of the target, we may have, perhaps 20 correct to 1 incorrect observation. This possible error in our supposition does not have a large influence upon our results.

If, therefore, among 10 shots observed, we have, on an average, 9 correct and 1 incorrect observation, so we shall have to continue our example, only 675 of the 750 short shots (i. e. $\frac{9}{10}$ of 750) observed in front of the target, the other 75 being observed in rear of the target. In the same way, of the 250 over shots, 225 will be observed in rear and 25 in front of the target. The number of shots which will be observed in front of the target, will therefore be, under this supposition, $675 + 25 = 700$; similarly for the number of shots observed in rear of the target, we have $225 + 75 = 300$. If the mean point of impact lies 25 m. in front of the target, we have consequently, the probability of the observation of one shot in front of the target equal to 7/10; that of the observation of one shot in rear is 3/10.

To make the problem general: let p (Table 1) be the number which represents the probability of *receiving* a short shot for any position of the mean point of impact with reference to the target, and q the same for an over shot: therefore $p + q = 1$. The probability P of *observing* one shot in front of the target would, by absolutely certain observation, naturally, be equal to p; and the probability Q of *observing* one shot in rear of the target, would be equal to q. But if among 10 observations only 9 are correct and 1 is incorrect, it follows from the preceeding, that the probability P of observing a short shot is $.9 \times p + .1 \times q$; and the probability Q of observing an over shot is $.9 \times q + .1 \times p$.

Now $.9p + .1q = \frac{9p + q}{10} = \frac{8p + 1}{10}$ (since $p + q = 1$).

In the same way $.9q + .1q = \frac{8q + 1}{10}$.

The probability P of observing a short shot is therefore $\frac{8p + 1}{10}$.

The probability Q of observing an over shot is $\frac{8q + 1}{10}$.

Example.—The mean point of impact lies 12.5 m. in front of the target; according to Table I, $p = .632$ and $q = .368$. The probability P of the observation of one shot in front of the target is consequently $\frac{8 \times .631 + 1}{10} = 6056$. The probability Q of the observation of one shot in rear is $\frac{8 \times .368 + 1}{10} = .3944$.

By means of this calculation the probability of the construction of a correct fork with reference to any target of which the range is known, can be readily ascertained. Suppose the range of a target is 2350 m., the fork is correctly constructed if the shots fired for the purpose are observed as follow:

2200 —
2400 +
2300 —

According to Table I, the probability p of receiving a shot in front of this target when firing at the elevation for 2200 m. is equal to 1 (since $2350 - 2200 = 150$). The probability q of receiving a shot in rear when firing with the elevation for 2400 m. is 0.911. And in like manner, the probability p of receiving a shot in front of the target, when firing with the elevation for 2300 m., is 0.911.

Accordingly, the probability that the shot fired at 2200 m. will be observed in front of the target is $\frac{8 \times 1 + 1}{10} = 0.9$; the probability that the shot fired at 2400 m. will be observed in rear of the target is $\frac{8 \times .991 + 1}{10} = 0.8288$; which is also the probability that the shot fired at 2300 m. will be observed in front of the target.

In order that the 200 m. fork shall be correctly constructed it is necessary that the shot fired at 2200 m., as well as that fired at 2400 m. be correctly observed. The probability of the occurence of the two events is, according to the principles of probabilities, equal to the product of the probabilities for the occurence of each event separately, therefore it is $0.9 \times 0.8288 = 0.7452$. In the same way the probability that the 100 m. fork shall be correctly constructed is $0.9 \times 0.8288 \times 0.8288 = 0.6176$. If all of the observations were always correct, the probability of correct construction of the 200 m. fork would be $1 \times 0.911 = 0.911$; that of the correct construction of the 100 m. fork would be $0.911 \times 0.911 = 0.8299$.

If the target distance were 2325 m. instead of 2350 m., the probability of a correct conrtruction of the 200 m. fork would, by uncertain observation, be increased to 0.795; on the other hand, that for the 100 m. fork would be decreased to 0.556. By absolutely certain observation the probabilities of correct construction of these forks would be 0.977 and 0.713, respectively.

So we see, the success of the correct construction of a fork depends not only upon the trustworthiness of the observations,

but also, in great measure, upon the accidental situation of the targets. The nearer the middle of the fork lies to the target, so much greater is the prospect that the fork will be correctly constructed. The shooting, however, is not so much for the purpose of finding the probability of the correct construction of a fork for a definite position of the target, as for finding out with what degree of certainty a conclusion as to the distance of the target can be drawn from the observations of the shots fired.

By the method employed for the ranges of 2350 and 2325 m., let us calculate the probability figures for an entire series of distances (for example, 2050, 2075, 2100, 2125, etc., to 2650 m.) by using the shots, which, fired with elevations corresponding to the respective ranges, were observed as follows: 2200 —, 2400 +, and 2300 —. We may now construct a curve, laying off to scale, upon a right line taken as the axis of abscissas, the ranges 2050, 2075, 2100, etc., to 2650 m., and as ordinates the probabilities calculated for these ranges; in our case, for example, for 2325 m. the ordinate would be 0.556, for 2350 m. 0.618, etc. The ordinates for the three shots given—2200, 2300 and 2400—would be those resulting from observation. The length of the ordinate terminated by the curve (see Plate II, fig. 2) will give the probability that the observation turns out as supposed for each distance of the target. Now it is clear that the probability (in reality the probability that the observations of the three shots result as here given) is proportional to the probability that the target itself is to be found at the corresponding distance. In our example the probability that the range is 2350 m. is to the probability that the range is 2325 m. as 0.618 is to 0.556 or as 1.11 is to 1; that is to say, if the observations of the shots fired with the elevations for 2200, 2400, and 2300 m. result as here given, then it is more probable that the target stands at 2350 m. than at 2325 m.

The probability that the target lies between two limiting distances, for example, between 2300 and 2400 m., (that is, the probability that the fork of 100 m. is correctly constructed) is equal to unity (a certainty), since the surface contained between the respective ordinates (cross-hatched in fig. 2) is equal to that enclosed by the entire curve (integral). If the calculations were gone through with in the manner heretofore given for the distances 2350 and 2325 m., there would be no end to the work; at all events, the work thus applied would be entirely out of proportion to the results obtained.

This calculation admits of being very much simplified. To this end we make use of the following table, which gives the

probabilities P and Q that a shot will be observed in front or in rear of the target, under the supposition that the mean point of impact has a determinate position with reference to the target, that the mean spread amounts to 50 m., and that, of every ten shots, nine will be correctly and one incorrectly observed.

TABLE II.

1	2	3	4	5	6
Position of the mean point of impact with reference to the target.		Probability P of observing a short shot.	log P	Probability Q of observing an over shot.	log Q
Mean spread (s)	m				
— 3.00	— 150	0.9000	9.954	0.1000	9.000
— 2.75	— 137.5	0.8999	9.954	0.1001	9.000
— 2.50	— 125	0.8997	9.954	0.1003	9.001
— 2.25	— 102.5	0.8990	9.954	0.1010	9.004
— 2.00	— 100	0.8972	9.953	0.1028	9.012
— 1.75	— 87.5	0.8927	9.951	0.1073	9.031
— 1.50	— 75	0.8828	9.946	0.1172	9.069
— 1.25	— 62.5	0.8633	9.936	0.1367	9.136
— 1.00	— 50	0.8291	9.919	0.1709	9.233
— 0.75	— 37.5	0.7754	9.890	0.2246	9.351
— 0.50	— 25	0.70	9.845	0.30	9.477
— 0.25	— 12.5	0.6057	9.782	0.3943	9.596
∓ 0.0	∓ 0	0.50	9.699	0.50	9.699
+ 0.25	+ 12.5	0.3943	9.596	0 6057	9.782
+ 0.50	+ 25	0.30	9.477	0.70	9.845
+ 0.75	+ 37.5	0.2246	9.351	0.7754	9.890
+ 1.0	+ 50	0.1709	9.233	0.8291	9.919
+ 1.25	+ 62.5	0.1367	9.136	0.8633	9.936
+ 1.50	+ 75	0.1172	9.069	0.8828	9.946
+ 1.75	+ 87.5	0.1073	9.031	0.8927	9.951
+ 2.0	+ 100	0.1028	9.012	0.8972	9.953
+ 2.25	+ 112.5	0.1010	9.004	0.8990	9.954
+ 2.50	+ 125	0.1003	9.001	0.8997	9.954
+ 2.75	+ 137.5	0.1001	9.000	0.8999	9.954
+ 3.00	+ 150	0.1000	9.000	0.9000	9.954

This last condition distinguishes Table II from Table I, since in the latter all observations were set down as correct. Colums 3 and 5 in Table II are calculated from the formula $P = \frac{8p + 1}{10}$ and $Q = \frac{8q + 1}{10}$, in which p and q are taken from Table I. The use of Table II as here given would very much shorten the necessary calculations, since the logarithms of the probabilities to be multiplied need only be copied and added. However we may provide a device to still further lessen the labor of the calculations. For this purpose cut from a piece of card paper a strip, and divide it into equal spaces from one to two cm. wide. In these spaces write the numbers of column 4 of the table (the

logarithm of the probability of the observation of a short shot) from right to left. Thus we have a "Strip for Short Shots," to which we prefix the minus sign. For our purpose it is sufficiently accurate if we carry out the logaritmhs to two places of decimals and also take as our intervals of distance 25 m. instead of 12.5 m. Where greater accuracy is required the logarithms may be carried out to three places of decimals and the intermediate distances may also be recorded. The column which corresponds to the probability of the observation of a short shot, when the mean point of impact falls at the target (where the number 9.70 stands) is indicated by the mark (ↄb).

The "Strip for Over Shots" is constructed by writing the numbers in column 6 in the same manner, prefixing thereto the plus sign. To illustrate these strips :

For short shots :

							ↄb					
—	9.00	9.00	9.01	9.07	9.23	9.48	9.70	9.85	9.92	9.95	9.95	9.95

For over shots :

							ↄb					
+	9.95	9.95	9.95	9.95	9.92	9.85	9.70	9.48	9.23	90.7	9.01	9.00

These strips would really be of infinite length; but the probability of the observation of a short shot, according to the supposition made, is at the most, 0.9 (log of 0.9 = 9.95), when all the shots lie in front of the target, and at the least, only 0.1 (log of 0.1 = 9.00), when all of the shots lie in rear of the target. Therefore the "Strips" will all begin and end with the repetition of the numbers 9.00 or 9.95. Now draw a straight line and divide it into parts which correspond to the width of the spaces on the strip; number these parts to correspond to the ranges which can come into consideration, for example, 2000, 2025, 2050, etc., to 2600.

In order to ascertain, by the method under discussion, the probability of the observation in front of the target, of a shot fired with the elevation for 2200 m., place the strip for short shots with the mark (ↄb) on the number 2200, then under the number 2150, for example, stands 9.23, which means that the probability, that a shot fired with the elevation for 2200 m. will be observed in front of the target, is the number whose logarithm is 9.23 (= 0.17), if the target stands at a distance of 2150 m. In the same way, it is found that the probability is the number whose logarithm is 9.95 (= 0.9), if the target distance is 2275 m. or more, etc.

TABLE III.

	−	+	Sums	Number corresponding to the log.
2000	9.00	9.95	8.95	0.09
2025	9.00	9.95	8.95	0.09
2050	9.00	9.95	8.95	0.09
2075	9.00	9.95	8.95	0.09
2100	9.01	9.95	8.96	0.09
2125	9.07	9.95	9.02	0.10
2150	9.23	9.95	9.18	0.15
2175	9.48	9.95	9.43	0.27
2200	9.70	9.95	9.65	0.45
2225	9.85	9.95	9.80	0.63
2250	9.92	9.95	9.87	0.74
2275	9.95	9.95	9.90	0.79
2300	9.95	9.95	9.90	0.79
2325	9.95	9.95	9.90	0.79
2350	9.95	9.92	9.87	0.74
2375	9.95	9.85	9.80	0.63
2400	9.95	9.70	9.65	0.45
2425	9.95	9.48	9.43	0.27
2450	9.95	9.23	9.18	0.15
2475	9.95	9.07	9.02	0.10
2500	9.95	9.01	8.96	0.09
2525	9.95	9.00	8.95	0.09
2550	9.95	9.00	8.95	0.09
2575	9.95	9.00	8.95	0.09
2600	9.95	9.00	8.95	0.09

If we now lay one of the strips for over shots with the mark under the range number 2400, and then add the logarithm standing in the perpendicular column, the sum so obtained is the logarithm of the probability that the shot fired with the elevation for 2200 m. will be observed in front of the target, and that, fired with the elevation for 2400 will be observed in rear of the target. The number corresponding to this logarithm is the required probability.* Table III will make the method plain. The taking out of the logarithms will be greatly facilitated by the use of Table IV. This is the reverse of the ordinary logarithm table, where the logarithm of every one of the series of natural numbers is given; in Table IV, the number corresponding to every logarithm from 1 too 100 is given. This table can of course of extended indefinitely and the logarithms carried out to a greater number of decimal places.

With the numbers of Table III (last line) we may now construct a cuive in the manner described on page 143, of which the ordinate will correspond to the probability that a shot fired with the elevation for 2000 m. will be observed in front, and one with the elevation for 2400 m. in rear of the target, when the distance of the target corresponds to the abscissa (Plate II, fig. 1).

We see from the data of Table III, as well as from the figure, that the probability that the two shots fired with elevation for 2200 and 2400 m. will be observed as stated (one in rear and one in front of the target) is greatest when the distance to the target is 2300 m.; it

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* Remembering that the probability of the occurence of two separate independent events is equal to the product of the probabilities that each of these events will occur.

is there, for example, about eight times as great as when the distance to the target is 2125 or 2475 m. We conclude from this, inversely, that if these shots are observed as above mentioned, the probability that the distance to the target is 2300 m. is greater than the probability for any other distance; and that it is about eight times more probable that the target distance is 2300 m, than that it is 2125 m. (or 2475 m.)

TABLE IV.

Log.	Num.	Log.	Num.	Log.	Num.	Log.	Num.	Log.	Num.
01	10	21	16	41	26	61	41	81	65
02	10	22	17	42	26	62	42	82	66
03	11	23	17	43	27	63	43	83	68
04	11	24	17	44	28	64	44	84	69
05	11	25	18	45	28	65	45	85	71
06	11	26	18	46	29	66	46	86	72
07	12	27	19	47	30	67	47	87	74
08	12	28	19	48	30	68	48	88	76
09	12	29	19	49	31	69	49	89	78
10	13	30	20	50	32	70	50	90	79
11	13	31	20	51	32	71	51	91	81
12	13	32	21	52	33	72	52	92	83
13	14	33	21	53	34	73	54	93	85
14	14	34	22	54	35	74	55	94	87
15	14	35	22	55	35	75	56	95	89
16	14	36	23	56	36	76	58	96	91
17	15	37	23	57	37	77	59	97	93
18	15	38	24	58	38	78	60	98	95
19	15	39	25	59	39	79	62	99	98
20	16	40	25	60	40	80	63	100	100

The probability that the fork of 200 m. is correctly constructed, or that the target stands within the limiting distances—2200 and 2400 m.—remains equal to unity (1), since the area of the cross-hatched surface is equal to the entire surface bounded by the curve (Plate II, fig. 1). The probability is, as already mentioned, theoretically infinitely great, on occount of the supposition that of all shots fired $\frac{9}{10}$ will be correctly and $\frac{1}{10}$ incorrectly observed; therefore the two branches of the curve will run parallel to the axis of abscissas. However, it appears that the probability of the incorrect observation of a shot falling 200 m. in front or rear of the target is very small, and indeed a shot falling 200 m. in front or in rear of the target will be observed with a much greater degree of certainty than that indicated by the ratio of one incorrect observation in every ten. We will therefore consider the observation of all shots falling more than 300 m. from the target as absolutely reliable; that is to say, we will take into consideration only about 300 m. (to scale) of the curve on each side of its highest point, which point corresponds to the most probable target distance. This will approximately correct the error of our

TABLE V.

	From Table III.		Sums	Number
2000	8.95	9.00	7.95	0.009
2025	8.95	9.00	7.95	0.009
2050	9.95	9.00	7.95	0.009
2075	8.95	9.00	7.95	0.009
2100	8.96	9.00	7.96	0.009
2125	9.02	9.00	8.02	0.010
2150	9.18	9.00	8.18	0.015
2175	9.43	9.00	8.43	0.027
2200	9.65	9.01	8.66	0.046
2225	9.80	9.07	8.87	0.074
2250	9.87	9.23	9.10	0.130
2275	9.90	9.48	9.38	0.240
2300	9.90	⅄ 9.70	9.60	0.400
2325	9.90	9.85	9.75	0.560
2350	9.87	9.92	9.79	0.620
2375	9.80	9.95	9.75	0.560
2400	9.65	9.95	9.06	0.400
2425	9.43	9.95	9.38	0.240
2450	9.18	9.95	9.13	0.130
2475	9.02	9.95	8.97	0.093
2500	8.96	9.95	8.91	0.081
2525	8.95	9.95	8.90	0.079
2550	8.95	9.95	8.90	0.079
2575	8.95	9.95	8.90	0.079
2600	8.95	9.95	8.90	0.079

supposition, that all shots will be correctly observed. In our example also, the probability that the target stands between 2200 and 2400 m. (that the 200 m. fork is correctly constructed) is equal to 1, as in fig. 1. the area of the cross-hatched surface is equal to that lying between the ordinates for 2000 and 2600 m.

It is easily understood that the areas are always proportional to the equidistant ordinates (the sums that are given in the bottom line of Table III), by which we notice that the shaded surface has for its limit the ordinates for 2200 and 2400 m.; therefore the ordinate for 2000 and 2600 m. should be accepted as only half as great. These sums are for the shaded surface 5.56, and for the entire surface 7.86.

Let w denote the desired probability for the correct construction of the fork; then we have $w:1::5.56:7.86$; hence $w = \frac{5.56}{7.86} = .707$; in other words, under the supposition made (mean spread 50 m., $\frac{1}{10}$ of all shots incorrectly and $\frac{9}{10}$ correctly observed), of every hundred forks of 200 m., the probability is that 70.7 will be correctly and 29.3 incorrectly constructed. For the construction of the fork of 100 m. a shot must be fired with the elevation for 2300 m., and the observation taken. To ascertain the probability for a correctly constructed fork a strip for short shots with the mark (⅄) at 2300 m. will be placed under the line of Table III giving the sums of the logarithms; the sums of the logarithms in the table and on the strip will be taken and the corresponding numbers set down (see Table V).

The bottom line of this table shows that the greatest probable target distance is not more than 2350 m. We calculate from this the area of the surface bounded by the curve from 2050 to 2650 m. (the value of the ordinates for distances over 2600 m. remains at 0.079). The probability that the target lies between 2300 and 2400 m. (that the 100 m. fork is correctly constructed) is found by the foregoing practical method to be $\frac{2140}{4083} = 0.524$; that is, for every 100 forks of 100 m., there will probably be 52.4 correctly, and 47.6 incorrectly constructed.

Let us extend our investigation to a fork of 50 m. For this purpose a shot is fired at 2350 m. If this gives a + observation (over shot) the probability that the target stands between 2300 and 2350 m. is 0.387. If it gives, on the otherhand, a minus observation (short shot) the probability of the correct construction of the fork of 50 m. (target between 2350 and 2400 m.) is reduced to 0.314 or in other words, nearly $\frac{2}{3}$ of all forks of 50 m. will be incorrectly constructed (see fig. 3 and 4 of the Plate).*

We have previously investigated two cases, namely:

Case I.	Case II.
2200 —	2200 —
2400 +	2400 +
2300 —	2300 —
2350 +	2350 —

In case I, the observations of the four shots furnish a very good guarantee that the target stands between 2200 and 2400 m., the probability of this amounting to 0.707, after the delivery of the first two shots; it is increased, after the observation of the last two shots, to 0.878 (see fig. 3).

In the second case, on the other hand, the probability for the correctness of the 200 m. fork is diminished by the observation of the last two shots to 0 503; that is, in this case the probability that the target lies at a greater distance than 240c m. is proportionally greater (see fig. 4).

For this reason the Austrian Firing Regulations contain the provision that when only one of the shots fired for the construction and narrowing of the fork is observed in front of the target, and all the others in rear of it (or vice versa), the shot in question shall be repeated in order to "control" the fork.

We will now investigate the correctness of the fork construction when one cause of incorrect forks, namely, incorrect observation

* These calculations as well as all that follow have been worked out with three place logarithms, and range intervals of 12.5 m. instead of 25 m.

is entirely elininated, and the "scattering" is the only remaining source of error. The method of the examination is exactly the same as before, except that we turn to Table I instead of Table III for the application of our "strips."

We find then, that the probability for the correct formation of the 200 m. fork increases from 0.707 to 0.851, and that of the 100 m. fork, from 0.524 to 0.707 (see fig. 5 and 6). If the shot fired at 2350 m. falls in rear of the target (case I), the probability that the 50 m. fork is correctly constructed is 0.509 (against formerly 0.387); if, on the contrary, it falls in front of the target (case II), the probability of the correct construction of the fork is 0.485 (against formerly 0.314). In each case the increase in the probability of the correct construction of the 50 m. fork due to correct observation is very small.

The most of my honored readers will be astonished at the large number of incorrectly constructed forks, and will perhaps think that these results are in contradiction to those of actual experience.* But the opposite is the case, as I have shown conclusively in the work intitled "Correctness of Fork Construction." I have frequently brought to my notice, during the revision of Shooting Lists, or in discussions, the entirely erroneous view that the fork will be correctly constructed if all the shots fired for the purpose are correctly observed. It is evident that by such a definition we shall receive a greater number of "correctly constructed" forks. But the correctness of the fork construction is as much influenced by a shot having a large deviation from the mean trajectory, as by an incorrect observation. If, in spite of correct observation, a fork be incorrectly constructed on account of the deviation of one of the individual shots which, under certain circumstances, may be but a very small deviation, the battery commander naturally discovers no fault. But the mere fact that the fork is incorrect (e. g. if for a target of 2199 or 2401 meters, a fork of 2200/2400 is constructed) will make no difference. Incidentally notice, that the fork may be correctly constructed by means of incorrect observation; if, for example, a shot which must cause an incorrect construction of the fork in consequence of its deviation, be accidentally incorrectly observed. We may also have a case of correct fork construction if the probable target distance is so near one of the two fork limits that, by a continuation of the shots upon this limit, we find we have determined the range (that is, the least practicable correction—25 m.—would not improve the situation of the mean trajectory, and would perhaps

* I will later compare the results of calculation and experience.

make it worse). According to this definition, there would be among a 100 forks of 200 m. 78.3 instead of 70.7 correctly constructed; and of the forks of 100 m., 65.3 instead of 52.4.

Now, every incorrect construction of the fork is not equivalent to a failure of the shooting; the correct construction of the fork only insures a greater success. According to the Firing Regulations for the Field Artillery, a fork of 100 m. will be constructed by firing with shrapnel, alternating with time fuse shrapnel, and fired at the two fork limits. The Target Practice Book regards the bursting point as unfavorable, if among six shots more than one falls in rear of the target; in other words, if the mean "bursting distance" comes under 20 m.; on the other hand, we read (Par. 41) that mean bursting distances of from 30 to 130 m. give good results. Proceeding on the supposition that mean bursting distances from 20 to 130 m. will probably give good results, we can by time fuse shrapnel firing, alternately upon both limits of the 100 m. fork, expect to get good results at least at one of the limits, and from one-half of all the shots fired, if the target stands no more than about 30 m. nearer than the short fork limit, or about 80 m. farther than the long fork limit, supposing that the fuses burn correctly. If the fork is constructed between 2300 and 2400 m., we may therefore count upon good results if the target stands between 2270 and 2480 m. The probability that this is the case, taking from Table V, is $\frac{3242}{4083} = 0.794$; that is, in 20.6 % of all cases we cannot expect to receive effective results from the alternate firing at the two limits of the 100 m. fork.

According to par. 94 of the Target Practice Book, if it is plain that the range is short, the firing in these circumstances should alternate upon the long fork limit and a distance 100 m. greater.

In our example we may therefore, as will appear later, be permitted to count upon effective results if the target stands at a range not greater than 2580 m. The probability that the target stands between 2270 and 2580 m., is calculated to be 0.87, i. e., in 13 % of all cases there will be no sufficient effect obtained. It is most likely then, if we get no apparent results, that the target stands nearer than 2270 m., when in changing the time fuse shrapnel firing to the short fork limit, according to our rule, the remainder of the percussion fuse shots are observed in rear of the target, in which case we should proceed to the construction of a new fork.

It must here be remarked, that these deductions only hold for the case where the bisecting shot of the 200 m. fork (shot at 2300

m.) is observed in front of the target. If it be observed in rear of the target, so that the fork must be constructed between 2200 and 2300 m., this in no way alters the probability that the fork will be correctly constructed. Consequently, the probability of receiving effective results by the time fuse shrapnel fire, at both fork limits, remains approximately unchanged.* On the other hand, we can in this case rarely expect effective results more than about 100 m. beyond the long fork limit, then the probability that the target stands between 2170 and 2480 m, is 0.81, while the probability that the target stands between 2170 and 2380 m., is 0.79. It will often happen when changing the time fuse shrapnel firing, under the rule, to the short fork limit, that the already loaded percussion fuse shots will be observed in rear of the target, and this necessitates the construction of a new fork, with a short limit 100 m. smaller than before.

In the same way that we calculate the probability of the correct construction of a fork, we may determine the probable position of the target by means of several shots fired with the same elevation (group shooting). The method of investigation is exactly that heretofore described. According to the Target Practice Book (par. 80) one can safely consider the battery as shooting at the proper range, if $\frac{1}{8}$ to $\frac{7}{8}$ of the observed shots lie in front of the target. If necessary, corrections shall be made, according to the rule, after six observed shots are fired. One is also shooting at the proper range if he has observed:

1. 3 shots — and 3 +
2. 4 " — " 2 +
3. 2 " — " 4 +
4. 2 " — " 2 +

The fourth case fulfils the requirements, although only four shots have been observed, because the proviso of the Target Practice Book (par 80) is independent of the observation of the fifth and sixth shots, without which $\frac{1}{8}$ to $\frac{7}{8}$ of the shots would still be observed in front of the target.

The most probable position of the mean point of impact, is, in the first and fourth cases, at the foot of the target; in the second case about sixteen meters in front; and in the third sixteen meters in rear of the target; and this depends, not at all upon the reliability of the observation, but solely upon the amount of scattering or spread. If this, for example, be doubled, the mean point of impact in the second and third cases will lie

* It falls from 0.794 to 0.788, which is practically the same thing.

twice as far from the target; if it be halved, the mean point of impact comes correspondingly nearer to the target.

What interests us here most of all, is the degree of certainty with which we may settle upon a definite position of the mean points of impact with reference to the target, basing our conclusions upon the observations of our "Range Shooting." The next thing is to establish what is to be understood by correct "Range Shooting." I understand it to mean, such a position of the mean point of impact with reference to the target, that the least practicable correction (for the Field Gun, 25 m.) will not improve the position of the sheaf, but the reverse. We have correct range shooting at 2300 m., for example, if the target stands between 2287.5 and 2312.5 m. The probability for this is 0.271 in the first case (3 shots — 3 shots +) (fig. 8); in the fourth case (2 —, and 2 +) it is 0.171 (fig. 9); if the limits between which the target is allowed to stand be extended, for example, from 2257 to 2325 m., these probabilities increase to 0.481 and 0.314 respectively. From this we see that the probability of having excact range shooting is by no means very great, although in both these cases the probability that the target is at a distance of 2300 m. is greater than that for any other distance (compare fig. 8 and 9). In the second and third cases the probability that the target stands between 2287.5 and 2312.5 m. is 0.237. The most probable target distance is in these two cases 2284 and 2316 m. respectively* (fig. 10).

If we suppose in advance that only correct observations are to be considered, this naturally increases very materially the reliability of the range shots in the first and fourth cases, for example, in the first case (3 shots —, 3 shots +) the probability of exact range shooting (target between 2287.5 and 2312.5) increases to 0.476 (instead of 0.271); the probability that the target stands between 2275 and 2325 m. would increase to 9.793 (instead of 9.481). Under the supposition of a mean spread of only 25 m. (measured by the range table 23 m.) the probability, by the observation of three shots in front and three shots in rear of the target, of exactly correct range shooting would be 0.793. In the fourth case (2 —, 2 +) the probability of exactly correct range shooting increases to 0.395, instead of 0.171. In the second and third cases (4 —, 2 + and 2 —, 4 + respectively) the probability

* It may be remarked that the probability of correct range shooting comes out very often considerably greater if we also consider, as we properly should, the shots fired for the construction of the fork. Since it is not here a question of absolute, but rather of relative accuracy, we can in the interest of simplicity, omit this refinement.

of correct range shooting increases to 0.316, instead of 0.120. (Fig. 11 to 13).

From the foregoing investigation, it is to be seen that the certainty of correct fork construction is by no means very great. For this reason there are in the firing regulations of all countries, certain rules intended to prevent the failure of the trial shots. For instance, in Germany, as is well known, it is prescribed that time fuse fire with shrapnel shall be used alternately upon the two fork limits, and under certain circumstances shall also be used at a distance 100 m. greater than the long fork limit. In this last case the method is very slow, even on the proving ground; in the presence of the enemy, perhaps too slow. Moreover the regulation, prescribing that a new fork shall be built, if, by changing to the time fuse fire, the already loaded percussion fuse shots are collectively observed in rear of the target, increases the certainty of the results.

The Russian (and older Austrian and the French) firing regulations prescribe for the control of the fork, a second shot to be fired at each fork limit. If the observation of the second shot turns out the same as the first, the respective fork limits may safely be regarded as correctly ascertained; if the observations are contradictory, two other trial shots must be fired. If the observation of these two shots agrees with that of the first two shots above, they are taken as correct, as are also the respective fork limits thus determined. If, on the contrary, the observation agrees with the second pair of shots above, the first pair of shots, and therefore the respective fork limits, must be regarded as incorrect. Finally, these two shots may be differently observed, but of the four shots, two may lie in front and two in rear of the target, in which event the respective fork limits are regarded as target distances, and we change at once to time fuse fire.

We will now investigate reliability of forks of 200 and 100 m. when thus controlled.

If the fork be constructed at 2200/2400 m., and two shots at 2200 m. are observed in front of the target, and two at 2400 m., in rear of the target, the probability that the target stands between 2200 and 2400 m. is 0.895, while the probability of the correctness of the uncontrolled fork is only 0.707. By means of the control, the number of incorrectly constructed forks will be reduced from 29.3 % to 10.5 %, a reduction of almost of one-third. If the firing be alternately with the time fuse shrapnel at 2020, 2300 and 2400 m., we may count upon receiving, in 97 % of all cases, favorable mean bursting distances (from 20 to 130 m.)

at one of the three ranges; while, by an uncontrolled fork of 200 m., we may rely upon effective results in only 86.5 % of all cases; that is, in only 86.5 % of all cases may we expect the target to stand between 2170 and 2480 m. (compare fig. 14 with fig. 1).

If the wide fork were constructed between 2200 and 2400 m., and the fork of 100 m. between 2300 and 2400 m., and if the control of this fork gives two shots in front of the target at 2300 m., and two in rear at 2400 m., the probability that this fork is correctly constructed will be 0.763, against 0.524 for the uncontrolled fork, the number of incorrect forks is also reduced from about 48 to 24 %—a reduction of one-half. The probability of getting the target within the mean bursting distance—20 to 130 m.—at one of the ranges, when firing with time fuse shrapnel alternately at 2300 and 2500 m. is 0.886, against 0.79 by the uncontrolled forks. The number of failing shots is reduced by the control from 21 to 11 %—a reduction of about one-half (fig. 15).

The prospect of obtaining a correct fork of 100 m., is naturally smaller than that for a correct fork of 200.; therefore, the effect of the alternate fire upon the limits of the 100 m. fork is about half greater than it is when the space between the limits of the 200 m. fork is taken under fire. The ratio is here entirely similar to that of all business enterprises; a high degree of certainty is always combined with relatively small profits, and high profits are always attended by a greater risk.

The control does not always turn out so favorably as here assumed. We have yet to examine how large the probability of correct fork construction is, if at one limit the first two shots are manifestly incorrectly observed, and only the following shall contribute to the correctness of the fork. Suppose, for example, that at 2400 m. two shots are +, at 2200 m. 1 + and 3 —, by our observation. In this case the most probable target distance will not be, as in the cases taken heretofore, 2300 m. or perhaps larger, the calculation gives about 2235 m. The probability that the target stands between 2200 and 2400 m. is 0.875 (fig. 14 a), only about 0.02 less than if at the outset by the control, two shots at 2200 m. had been observed in front of target. In the same way, the probability of obtaining mean bursting distances from 20 to 130 m. by the time fuse fire at 2200, 2300 and 2400 m. successively is somewhat smaller (0.95 against 0.97). The probability of the correct construction of the fork is always considerably higher by the controlled, than by the uncontrolled method. It is easily seen that the calculation for the 100 m. fork will turn

out entirely similar, so that the deduction of these results will not be required.

The probability that, if four shots, fired at the same elevation, are observed two in front, and two in rear of the target, this distance can be regarded as proven to be correct, has already been given above (page 153). The probability that with the time fuse shrapnel fire at this distance, we shall get the target within the mean bursting width of from 20 to 130 m. is calculated to be 0.487 (fig. 9). That is not very high, but we must notice that, if the other fork limit is controlled, this is somewhat increased (to about 0.54). If the firing is all at one range, the effect is naturally twice as great, or three times as great, as if the firing were alternately at two or three ranges; since in these cases one-third or two-third of all the shots must have unfavorable bursting widths.

Let us investigate one more particular case. In the second edition of my "Artillery Fire Game" I made the proposition to control the 200 m. fork, and afterwards to open with a time fuse shrapnel fire at the distance bisecting this fork.* If the already loaded percussion fuse shots are observed to fall half in front and half in rear of the target, we should not disperse the shot, but continue the time fuse shrapnel fire with this distance. Therefore, the control of the limits of the wide fork increases very considerably the probability that the target distance agrees with the distance which bisects the wide fork. For example, if at 2200 m. two shots are observed in front, at 2400 m. two in rear of the target; at 2300 m. two in front, and two in rear of the target, the probability that the target stands between 2270 and 2280 m., or, what is the same thing, the probability that by time fuse shrapnel fire at 2300 m., with correctly burning fuses we get the target within the mean bursting width of 20 to 130 m., is 0.78, that is, almost exactly the same as the probability (0.79) of getting a favorable mean bursting width at one of the fork limits, after building a 100 m. fork by time fuse shrapnel fire alternately at the two fork limits. The effect is exactly twice as great when firing at a single distance. This favorable result will be attained by the delivery of one more percussion fuse shot (fig. 16).

The new French "Manuel de tir" gives another method of controling the fork, the "verification de la hausse." Suppose

* The proposition was to control the 200 m. fork and to change to the time fuse shrapnel fire at the distance which bisects the fork. If the observations show a majority of shots in front of the target, the bisecting distance should be taken instead of the greater fork distance—if more shots in rear of the target, the short fork distance should take the place of the long one; if, on the contrary, the shots are seen to fall equally in front and rear of the target, the bisecting distance should be retained as the true range.

the fork of 2200/2400 m. to be constructed; now fire a shot at the bisecting distance of the fork—2300 m. If this be observed in front of the target, the long fork limit (2400 m.) will be controlled; if in rear, the short fork limit (2200 m.) will be controlled. The control will be carried out according to the above given rule. We may have

(a)	2200 −	(b)	2200 −
	2400 +		2400 +
	2300 −		2300 +
	2400 +		2200 −

If the control turns out favorably, of four shots in each case, two will be observed in front, and two in rear of the target.

The probability that by this control the 200 m. fork is correctly constructed is then found to be 0.881, that for the correctness of the 100 m. fork being 0.651. By firing alternately at the two fork limits we obtain in example (a) (2300 short fork) favorable mean bursting widths in 85.6 % of all cases, and in example (b) (2200 m. short fork) in 91 % of all cases (fig. 17). The control seems, in this manner, to give a high degree of certainty as well for the correctness of the fork, as for the result of the time fuse shrapnel fire. The number of incorrectly constructed 100 m. forks is decreased from 48 to 35 %. The number of failing shrapnel shots (by which one receives favorable mean bursting widths at neither of the two fork limits) is reduced from 21 % ($100 - 79 = 21$) to the mean value of 12 % ($100 - 88 = 12$). Under the supposition that all observations are correct, the probability of a correct construction of the 100 m. fork is increased by this control from 0.707 to 0.759.

From these deductions it is apparent that the control—of both fork limits or of only one—increases the degree of certainty of the range finding shots considerably.* The loss of time caused by firing one shot (for more is not necessary) cannot possibly come into consideration, for, everything depends upon the accuracy of the trial shots. On this account, there is, in the firing regulations of all countries, a rule, which recommends or prescribes such control. The regulations of France and Russia have already been mentioned. The Italian firing regulations prescribe the trial of the fork—especially at great distance—as soon as a doubt exists as to its correctness, in order to make the

* I will not deny that circumstances can arise under which the control by repetition of a shot promises no benefit. Let us consider, for example, that about 300 m. in front of a target at a range of 2500 m., a single small bush is found standing as a mask; in this case shots fired with elevations of 2300 or 2400 m., and striking behind the mask, but in front of the target, will very likely be incorrectly observed, as experience teaches. Such cases, no matter how seldom they arise, detract from the probability of control. In all other cases I consider the control very useful, no matter whether one supposes correct or unfavorable observations.

faults of observation and measurement of the least possible harm. The Swiss firing regulations order the proving of a doubtful* shot, by firing a second one at the same range. The Austrian regulations prescribe that, if, in the construction of the short fork (100 paces) one shot is observed in front, while all the other shots fired in the construction of the fork, are observed in rear of the target (or vice versa), the one shot in question shall be repeated. They go, therefore, not quite so far as the French regulations. In the cases explained on page 157, the Austrian regulations would not emyloy any control, but, suppose the data were about as follows:

(a)	2000 —	or (b)	2400 +
	2400 +		2000 —
	2200 —		2200 +
	2300 —		2300 +

In example (a) a second shot would be fired at 2400 m., and in example (b) at 2000 m. The German firing regulations prescribe that, after the formation of the 100 m. fork, time fuse shrapnel firing is done first at the short, and then at the long fork limit, alternately. If the fork is formed by the observation of three shots, (at 2200 —, 2400 +, 2300 +) the most probable target distance is, of course 2250 m., and therefore the alternating fire at 2200 and 2300 m. is entirely correct. If the observation of the loaded percussion fuse shots, after changing to the time fuse shrapnel firing results in more shots in rear than in front of the target, the most probable target distance is not more than 2250 m., but may be even smaller than 2200 m. Assuming that the fuses burn correctly, the most probable bursting width is about 50 m. (at 2200 m.) and therefore, in the above case, the bursting points undoubtedly lie about 100 m. in rear of the target. In this case it would be better to go back about 100 m. (the guns are already loaded, fuses cut); for, there is no reason to give more confidence to the first shot fired at 2200 m., than to the following percussion fuse, provided that they are well directed and intelligently observed, which is not always the case.

Suppose, that, after the command for time fuse shrapnel firing, one observes two shots in rear and one in front of the target (including also the shots fired in construction of the fork, two in front and two in rear of the target) then the fork distance becomes at once the most probable target distance. According to the probability curve, by alternate time fuse shrapnel firing at the two fork limits, one can count upon a mean bursting distance of 20

* "Doubtful" does not mean the same as "questionable." The regulation does not prescribe which is meant. It appears at all events to mean a shot, whose observation in the series gives occasion for reconsideration.

to 130 m. in 62 % of all cases; on the other hand, by alternating the fire between the short fork distance and a distance 100 m. smaller, we may count upon 77 % of all cases, that is, about one-fourth more (fig. 18). The operation, according to the firing regulations, would give a still more unfavorable result, if, of the remaining (loaded) shots, one is observed in front, and three or even four in rear of the target.

The firing regulations are, in may opinion, too rigid and binding—too hard and fast, on this point being in strict contradiction to the spirit of all other rules, which permit some latitude to suit the circumstances of the case. What is prescribed in the firing regulations might, under certain circumstances, be the worst possible thing that could be done.

For the continuation of firing with percussion fuse after the construction of the fork, it is possible to make a few abbreviations which can be of some consequence in the firing of torpedo time fuse shells. According to paragraph 79 of the firing regulations, after the formation of the 50 m. fork, the firing shall be continued at the short fork distance.*

According to paragraph 82 of the firing regulation, a "correction of 50 m. shall be made, if the first three shots at the same range show equal deviations. Should this correction of 50 m. prove to be too much, a second correction of 25 m. in the opposite direction will be made." This will generally be so understood that (most likely) six shots must be fired at the range in question before it can be taken to be correct. If, for example, three shots are observed in front of the target at 2300 m., and three in rear at 2350 m., the probability that 2325 will prove to be the correct range (that is, that the target stands between 2312.5 and 2337.5 m.) is 0.345; in other words, it is larger, than if we had observed three shots in front, and three shots in rear of a target standing at 2325 m., which latter probability is only 0.27 (see page 153). This is an interesting and surprising result and is principally useful in shortening the trial shooting.

The occasion now offers to investigate the value of the probability that the target stands in the middle of the narrow (50 m.)

* It may be incidentally remarked, that the distance which bisects a fork, has the greatest probability, as may be seen from all our calculations and curves. There is then no reason for the continuation of the firing at the short fork distance. It would be better to continue firing, either at the fork limits alternately, or at the distance bisecting the fork. If the fork is constructed at 2200, 2300 m., the narrow fork is determined by a shot at 2350 m. There is in my opinion no ground for going back to 2300 m., if a shot at 2350 m. is observed in rear of the target. That is useless waste of time. So long as one used powder shells, and expected good results from them, he had a good right to continue the firing at the short limit of the fork, then only shots in front of the target gave prospect of effective work. This is already changed by using torpedo shells against plainly visiable objects, and more so still against covered objects, when firing with percussion fuse, serve only to ascertain the range. Here it is solely a question of the shortest way to get at the target.

fork, if, at each limiting distance, only two shots are observed in front of the target and two in rear. This probability is 0.25, that is, it is a little less than if firing with the same elevation at one range, three shots are observed in front, and three in rear of the target; and, on the other hand, it is greater than if two shots were observed in front, and two in rear of the target; and twice as great as if four shots were observed in front, and two in rear of the target (or vice versa). What follows from these deductions? That by the observation of four shots in front, and two in rear of the target (or vice versa), one can consider himself to have found the range; consequently, the control of the 50 m. fork is sufficient evidence of a satisfactory determination of the range; then it affords the same, if not a greater, degree of certainty, for the correct investigation of the range, as if one had observed at one distance one-third to two-thirds of the shots in front of the target*.

The accurate shooting for the range with percussion fuse makes a change in the operations absolutely necessary. We have firing lists which show that one battery commander fired forty-eight (!) shots—in which questionable observations are doubtless included—before he considered himself to have found the range to within 25 m. It has been known to happen that sixty-five shots, i. e. 43 % (!) of the entire supply of the battery have been used for this purpose. This investigation retains its importance, even if the field guns of the future carry no torpedo shells, for the conditions are very little different when using howitzers.

What I desire to accomplish in my present work, is to prove that the operation of finding the range can be made more reliable, and at the same time shortened, and to show how this may be done. The more unreliable the observation, and the greater the scattering, the more uncertain will be the shooting for the range, and, therefore, the more necessary to control.

In peace maneuvres such errors as these do not perhaps make themselves of so much importance as would appear from the foregoing, and it may be for this reason, that the observations appear

* If we exclude entirely all incorrect observations, not all that we have said above will apply, but it in no way changes the result. Under this supposition, for instance the probability that one would be shooting at the correct range, if the middle of the 50 m. were taken as the distance, would be 0.41, when at each fork limit three shots had been observed in front or in rear of the target, respectively; and, it would be 0.355, if only two shots had been correspondingly observed. If one has observed three shots in front, and three in rear of the target, when firing at a single distance, the probability of obtaining, at this distance, correct range shooting is 0.476 (page 15[illegible]); with two shots in front and two in rear, the probability is 0.395. The probability that the distance, which bisects the fork, will prove to be the range, if at both fork limits two shots in front and two in rear are observed $\left(2300 \frac{-}{-},\ 2350 \frac{+}{+}\right)$ is indeed smaller than that given by the observation of four shots, fired with the same elevation, of which two were observed in front, and two in rear of the target (2325 —, +, —, +). But it is larger, at least, than if one, firing at a single range, had observed four shots in rear and two in front of the target (or vice versa), this probability being only 0.316 (page 153).

somewhat more reliable, and the scattering somewhat less than I have assumed. In serious work (war), toward which all peace maneuvres are directed, even the most excellent personnel (or staff) must doubtless assume the contrary, and thence becomes absolutely necessary a greater degree of certainty of the range finding shots, although taken between wider limits, but in that case no great accuracy can be expected.

That my suppositions are not so far from the truth, and especially, that my methods of calculation are reliable, may be seen from the following. In the second edition of my "Artillery Fire Game," I had published some results of the target practice of a battery (pp. 79 and 86). Two hundred and thirty-one firing records were examined—a collective body of shots, by which the range could be accurately established by the observations on the target. The fork of 220 m. was correctly constructed one hundred and fifty-eight times (68.4 % of all cases), and incorrectly constructed seventy-three times (31.6 % of all cases); the foregoing investigation (under the supposition that one-tenth of all the observations are incorrect, and that the mean length of scattering is 50 m.) gives 70.7 and 29.3 % respectively. The fork of 100 m. was constructed correctly one hundred and thirty-eight times (59.7 % of all cases) and incorrectly ninety-three times (40.3 % of all cases);our calculations giving 52.3 and 47.7 %, respectively. The shots at the two limits of the 100 m. fork, assuming correctly burning fuses, gave a prospect of favorable mean bursting distances one hundred and seventy-seven times (in 76.6 % all cases), the calculation gives 79.4 %. This agreement between theory and practice is well worth considering.

I would be pleased, if these deductions should give occasion to one person or another, for a wider investigation of the subject, even though a different result be obtained. The object is not that the foregoing deductions should come to be known as correct, but that the truth should be sought out, which generally first occurs through the refutation of error. However, I must earnestly protest against any man's laying aside these deductions at the outset, with the remark: "This is all only Theory, in Practice everything will be different." To these gentlemen I would be compelled to answer: "You call that 'Practice' which you cannot prove, and that 'Theory' which you cannot refute."

CONCLUSION.

The foregoing work was ready for the press, when a friend called my attention to the fact that the Government Secretary,

Dr. Pochhammer, Professor of Mathematics in the Kiel University, had also been engaged some time before, in an investigation of the reliability of the fork construction. This problem is still in the air, so to speak. Upon applying directly to the well known gentleman, he has been good enough to furnish me with the most reliable information. His investigation, with the help of the higher mathematics employed, extended solely to the construction of a fork by means of two shots—one short and one over—and all observations were assumed to be correct. The problem was in this way very much simplefied. Professor Pochhammer in his calculations arrived at the conclusion, that the probability P of correctly constructing a fork in this manner may be expressed by the formula

$$P = 1 - 0.59 \cdot \frac{s}{\gamma}.$$

In this formula "s" denotes the mean spread, and "γ" denotes the width of the fork. Under the supposition made by me, that $s = 50$ m. we get by this formula

$$P_{\gamma = 200\text{ m.}} = 1 - 0.59 \frac{50}{200} = 1 - 0.1475 = 0.8525$$

$$P_{\gamma = 100\text{ m.}} = 1 - 0.59 \frac{50}{100} = 2 - 0.295 = 0.705$$

$$P_{\gamma = 50\text{ m.}} = 1 - 0.59 = 0.41.$$

According to my calculation under the supposition of only correct observation (p. 150), we get

$$P_{\gamma = 200\text{ m.}} = 0.851$$
$$P_{\gamma = 100\text{ m.}} = 0.707$$
$P_{\gamma = 50\text{ m.}} = 0.509$ or 0.485, giving a mean of 0.497.

The agreement of the values for the forks of 200 and 100 m. is very close, and therefore will be an argument for the reliability of my adaptation of Capt. Magnon's method.

For the fork of 50 m., the difference is somewhat considerable; the reason for this lies, however, not in the incorrectness of my adapted method, but in the fact, that, as Dr. Pochhammer has had the kindness to inform me, the formula deduced by him is valid only for wide forks, and an alteration is necessary to make it applicable to narrow forks. Dr. Porhhammer excludes from his investigations all forks of which the probabiliʒy for their correctness falls under two-thirds; and this therefore allows the formula to be simplified.

That the formula does not hold for short forks can be immediately seen if we make $\gamma = 25$ m., in which case the formula gives

$$
\begin{aligned}
P_{\gamma = 25\,\text{m.}} &= 1 - \frac{50}{25} \cdot 0.59 \\
&= 1 - 1.18 \\
&= \quad -0.18,
\end{aligned}
$$

which is manifestly impossible, since a negative probability is plainly imaginary. Incidentally note, that the foregoing adaptaion of Magnon's method gives a probability of 0.271 that a fork of 25 m., constructed by the observation of two shots, is correct.

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[Translated by Lieutenant *J. A. Shipton*, 1st Artillery.]

SHRAPNEL FIRE FROM FIELD HOWITZERS AND MORTARS.

Discussion by MARTIN PREHN, Captain in Department of Fireworks. Former Superintendent of Proving Ground of Friedrich Krupp, Meppen.

Archiv für die Artillerie und Ingenieur-Offiziere, February, 1896.

The discussion of the effects of shrapnel fire from field howitzers and mortars is unavoidable, since there are, at the present time, so many opinions adverse to this kind of artillery. There is no better way of reaching living objects standing behind cover, but, at the same time, there is no shot harder to put into the right place.

This firing, scarcely controllable when using a single gun on the target range, escapes almost entirely from the control of the battery commander, not only in pitched battles, where there are naturally so many sources of error, but also in the more careful firing of sieges.

The idea which is superficially formed, by all but the advanced artillery officer, of the effects of shrapnel fire from field howitzers and mortars is erroneous, and, for that reason, this kind of fire is often wrongly estimated. With many it is compared to a rain, falling vertically, covering and beating down everything beneath it.

The question to be discussed is simply: what initial velocity is most suitable for shrapnel with the present system of field howitzers and mortars?

We are not considering a new system of guns and projectiles, but the best use to be made of the existing material by the simplest service, conditioned on the easiest and most reliable system of practicable observation.

High angle fire guns, called howitzers and mortars, on account of their mounting and their short bore, permit an elevation of at least 45°, therefore, on account of this property, it is often concluded that their province is to always fire in the greatest curved trajectory.

For this reason their position is often selected in such a manner as to take away from their facility for observation, which is the most essential condition for effective firing, since what the battery commander does not see he will not believe.

This advantage is lost, of course, when the opposing guns are

put up in covered positions, but in placing our own guns under cover the great advantage of being able to change the target at will is given up. In sieges the most dangerous enemy is not always the one we fire upon in previously determined directions. In the defense account is taken of this by arranging revolving turrets and the like.

The short bore of the high angle guns allows only a small chamber, and this permits the use of smaller charges, than the so called service charges, and also a variation in the initial velocity; the short chamber always gives sufficiently high gas pressures, and secures as far as is possible equal velocities.

It is otherwise in the longer cannon; the long chamber, which is fitted for a large charge, causes the small charges to fly apart and to burn irregularly from shot to shot.

The power of elevation allowed by construction therefore, no longer indicates the only difference between cannon and howitzers and mortars, as now all siege guns have a high power of elevation; this difference rather lies solely in the possibility of a variation in the charge. This change in the charge is required at various distances, depending on cover of the enemy and consequent smallest angle of fall.

Effective covering demands as the smallest angle of fall an angle of at least 25°; the tangent of 25° is 0.47; therefore with a parapet 0.47 m. high the closest hit will strike the ground one meter behind the interior crest. As the cover for a man would not be under 4×0.47 m. or 1.88 m., the closest hit in that case would fall at a distance of four meters from the interior crest, and as the trail of an enemy's cannon reaches to about 4 meters behind the parapet, so this angle of fall of 25° for a shrapnel will be considered sufficient to strike all stationary or moving objects behind the guns; besides, it is to be observed that a few shots which strike the parapet near the interior crest often pass through and become effective as battery hits. In the field there is usually no reason for so strong a protection for the artillery, a gun so protected is harmless, since it cannot be fired even although the cannoneers serve it kneeling. It must not be forgotten that every man believes himself covered if he cannot see the enemy from his position. How otherwise were the service of a gun possible?

The following illustration shows the efficiency of such a high covering: On the practice ground of a large force of artillery, firing under war conditions, a redoubt was to be fired on at a range of 2000 meters, which covered a portion of its men to over

45°. In firing 72 shrapnel from a battery of 12 cm. howitzers, there were found on the board targets representing these, naturally, very few hits, but in the remaining protected space there were about 55% of the targets, representing standing men, struck. The battery commander fired for the first time with these mortars, and the fire was, consequently, rather rapid fire than observation fire. The effect on the parapet with the small charge was, of course, unsatisfactory.

It is easy to obtain from the range table a charge which will give an angle of fall of 25° or greater, so that it should be easy in this firing with howitzers or mortars to solve every problem, which the covering of the enemy gives, by using the proper charge and elevation. It is fortunate for the defenders that this is not the case, however.

There are many circumstances which render it difficult to effectively strike narrow targets. There are mortars the accuracy of which with shell, at least on the target range, causes astonishment ; it is much easier to reach a hostile position behind cover by means of shrapnel and destroy the enemy, since the under side of the sheaf increases the angle of fall. The angle of fall may either be increased or diminished from the fact that the axis of the projectile is not always tangent to the trajectory but may make an angle with it in any direction. This deflection increases with the elevation and when reducing the initial velocity. The shrapnel always throws its bullets in the direction of its axis, so that the balls take a direction which cannot be fixed beforehand, consequently the shot may be useless; this is generally the case in firing at an elevation of 60° from which especially good results are expected when firing with curved trajectories. In shooting shrapnel from the 21 cm. howitzer, each containing 1700 balls, a total of 17000 balls, at a range of 2000 meters, at 60° elevation, the record of each shot was taken down, but, perhaps because the bursting point was unfavorable to the covering, the result was absolutely nothing. Notwithstanding more extended searches, not one of the 17000 balls was found within a radius of more than 100 meters. The bullets had gone neither too far nor had fallen short, they had simply disappeared.

Reliable observers stood near the targets and distinctly saw the course of the empty shells after the burst. This would always be possible since the path of the empty shells is independent of the path of the full shot, indeed in searching near the empty cases no balls were found. The fire of shrapnel under 60° is therefore to be avoided, aside from the fact that i nccmbat

no one will be in condition to follow changes in elevation exactly corresponding to cutting of the fuze.

It happens at times that the charge of balls is scattered to the right and left, and, although the most favorable bursting points are selected the whole charge of balls falls on one side or the other of the target.

This is of great importance in shooting at field batteries, where the guns are 15 meters apart. Seen from the side the cannoneers are all apparently destroyed, but upon searching all the balls are found lying between the pieces; yet the battery commander has seen all the shots explode at the proper point, and can only assure himself by personal inspection that he has missed. A peculiar phenomenon may be mentioned here which may influence the direction of the balls. In firing with low velocities, or with low elevations, it is noticed how the shrapnel at the moment of bursting suddenly stops, and sometimes even makes a distinct backward movement; there can in this case be no control of the scattering of the balls.

In both cases the velocity of the projectile is destroyed, the body falls vertically downward and the balls have at most the velocity which the bursting charge gives them. They probably lose some of that, as it can be shown by measurement that a shrapnel burst while suspended will give less velocity to the balls, than when fired with a strong support behind it. Therefore it cannot be depended on for great efficiency, although, in the base charged shrapnel, the velocity of the balls is the sum of the remaining velocity and that due to the bursting charge. If in firing with high velocities the stopping of the projectile is not seen, it is doubtless present and will influence the forward movement of the balls.

If this effect is sufficient to bring a shot with a velocity of from 100 to 130 metres to a state of rest it will decrease a velocity of 200 meters by a similar amount. Because the filling of the shrapnel is not a homogeneous mass, the stopping of the body is noticed before the forward movement of the balls; this same effect is noticed when a gun is fired, the gun recoils before the projectile moves.

In any case the force of the balls of the mortar shrapnel will not be much greater than that due to the bursting charge; this accounts for the fact, that, while boards of 3 cm. in thickness are pierced in an oblique direction when lying singly, a double layer of boards 2 cm. thick will not be pierced but the balls found lying on the under board; this is because they have not sufficient

velocity, after piercing the first board, to overcome the elasticity of the one beneath it, which is increased by the bending in of the one above. For this reason extremely light lines of approach in sieges, and thin parapets in military field works are sufficient to protect the personnel against mortar shrapnel and infantry fire.

An interesting case of the recoil due to the bursting charge was offered by a small mountain mortar of 7.5 cm. The enemy were situated at a distance of 200 metres and 100 metres above the gun as may occur in mountain warfare with wild tribes. Shrapnel (reaching them nearly horizontally), was necessarily used as they do not fear shell; and a small charge being selected so as to give a velocity of about 50 meters, a shell was fired to get the time of flight, which was followed by a shrapnel; this was burst at the right time and the body of the shrapnel received such a recoil that, retracing the same curve, it fell into the battery. The velocity of recoil of this part was greater than 50 metres, it must have been fully 100 metres, the excess over the remaining velocity due to the charge in the gun bringing the body of the shrapnel back into the battery. Occasion is also taken to mention here that often, with low velocities which permit an easy observation of the flight of the projectile, a cloud is seen which clearly indicates the moment of iguition of the bursting charge by the fuze, then, after a longer or shorter interval, the explosion follows, which evidently shows that the time, from the transmission of fire to the bursting charge to the burst, varies from shot to shot. This phenomenon has no influence upon the direction of the axis of the shot, but the bad effects are shown in variations in point of burst which cannot be avoided even with the best fuzes. A similar case to that of shrapnel is shown by percussion shell in which the bursting charge is packed together by the shock of firing, and acts slowly so that at times shell with percussion fuze can be fired through several thicknesses of boards before explosion. This especially takes place in cannon with with high velocities.

The efficiency of a shot depends on two factors: striking the object, and the force of the blow. The hitting of a shrapnel depends on many things, some of which may be fulfilled in its construction and causes of inaccuracy avoided. For the following discussion it must be accepted that these conditions have been fulfilled and that it is fitted to fulfill its object. It must in every case be accepted; that the length of the projectile is sufficient for stability of flight; that it contains a large number of balls which

are sufficiently heavy to be effective, and sufficiently hard to over come obstacles without deformation. It must also be assumed that, the location and size of the bursting charge is the best found by experiment, and so arranged as to obtain the quickest possible action ; that the difficulties in regard to stability of flight are overcome ; that the balls are scattered uniformly through the sheaf produced by the explosion of the bursting charge ; in short, it must be supposed that the artillery possesses the best imaginable shrapnel for its mortars and howitzers.

It is impossible without these conditions to have the necessary confidence in it and we cannot at every fancy of some quill driver be willing to adopt a new one. Still this assumption is not so easily fulfilled as it is made, there are many different kinds of shrapnel; shrapnel the bursting charge of which lies in the head in front of the balls (obus à mitraille) with percussion or time fuze, in both cases the rear action may be artificially increased by small charges, and thus, in the case of the time fuze insure a free falling of the balls ; shrapnel of which the bursting charge is placed at the base, the shell separating in front causes the sheaf to be more compact and of greater depth; other shrapnel the bursting charge of which, lying along an axial chamber, causes a hollow sheaf. (The base charged shrapnel will be the foundation for this discussion).

If we had at present the best shrapnel imaginable would an unquestionable success be obtained for the field howitzers and mortars?

In the first place this question must be answered in the negative, since the manufacture of a perfect mortar fuze has not been reached, and, as shown above, the time from the ignition of the bursting charge to the explosion is uncertain. The fuze will nevertheless be improved, though it may be long until the perfect form is reached. In consequence of the opinion, that the velocity of the balls is the sum of the velocity due to the bursting charge and the remaining velocity of the projectile, since it has been noticed that the recoil may be sufficient to entirely overcome the velocity due to the remaining velocity of projectile, it will be sought by means of some more powerful bursting charge to increase the velocity of the balls themselves, even though the velocity of the recoil of the body of the shrapnel be equally increased.

The difficulty of observation during battle will still remain, and the efficiency of this important means of fighting will be

questionable, if the shrapnel from high angle guns cannot be fired almost as confidently as those from cannon. This efficiency can be reached, if a high training in this difficult kind of artillery fire is given and the rules laid down that covered targets are to be fired upon by shrapnel only with medium charges, to use full charges against uncovered targets or for dismounting guns, and to employ the smallest charges when using shrapnel as shell at short distances.

In this way, the sight can become so practiced, that delusions due to incorrect observation are overcome as much as possible, so that the greatest efficiency is obtained from the gun, and the presence of mind, so necessary in action, is retained. It must also be learned that shrapnel from high angle guns can never be used in rapid fire—because its weight and the small supply in the limber forbid it—and because its physical as well as moral effect depends on the large size of the bursting charge.

In yielding to the demand for a single charge for indirect shrapnel fire, the distinctive characteristics of high angle fire disappear and the question then comes up at once: Wherein lies the authorization for the introduction of the field howitzer and mortar? This special weapon will solve problems for the solution of which the cannon, on account of its high velocities and straighter trajectory, is not fitted.

The shells of the field high angle guns, (even if replaced by shrapnel for penetrating,) for use against military redoubts and and in similar cases of sieges cannot be replaced by those of cannon. It has been sought to use cannon in this way by reducing the charge, but this so called curved fire is entirely inadequate because of inaccuracy, the small charges burn with little regularity which varies greatly the initial velocity, to changes in which this kind of fire is extremely sensitive; and beeause the slight twist of the older rifled cannon places the stability of flight of the projectiles in question. This last condition is better fulfilled in the recent cannon by a considerable increase in the twist of rifling which more nearly meets the needs of the high angle fire —since a twist which gives stability with low velocities will necessarily do so with high ones. The penetration due to fall of a shell from field pieces is, on account of its slight weight, insignificant.

The accuracy of shells out of high angle guns is satisfactory with all charges. The observation of the shell is independent of atmospherical conditions. and the cloud of smoke from the bursting charge easily seen, being much larger than that produced by

the shrapnel, this makes it easy to note the point of fall and gives a quick and satisfactory method of ranging the targets. In all high angle fire, the different charges should be used according to the distance of the objective and is true of shell.

Ordinary powder shells from cannon are not at all effective in front fire against shelter trenches, as a very large number of examples have shown, and shrapnel from cannon are not much more so, and even from high angle guns shrapnel are not always fully satisfactory.

It is for this reason that, the published trials of the efficiency of the different charges must be compared and a compromise made if possible.

As introductory are a few examples of the fire of cannon taken from the classical work of Lieutenant-General v. Müller, "The Effect of Field Guns, from 1815 to 1892".*

In this laborious work is given a most comprehensive review of the results of experiments in all countries with shell and shrapnel, investigated with painstaking care from every conceivable point of view, together with extracts from the most celebrated artillery writers from which can be obtained an idea of what to expect from them in time of war. Lieutenant-General v. Müller quotes (Pg. 182) from the French Colonel Langlois "All experiments to make use of shrapnel in high angle fire from mortars have been failures. All results obtained up to the present time have only confirmed this opinion."

This view is not agreed to in all its strictness, since it is not intended that shrapnel shall be fired in this way without special drill, and special regulations.

Respecting the execution of cannon, there are a great many experiments against ordinary targets, and against uncovered targets representing infantry and artillery under war conditions. These results are well known by nearly all artillerymen from their own practice.

Unfortunately there are but few examples among them in which covered targets were fired at. Among the latter the author took—page 48 from "*Giornale d'artiglieria*" 1883—a somewhat extended experiment against silhouette targets which was a part of the exercises of the Italian regiment, and which will serve as an example.

The trial was repeated five times at unknown distances—the results are placed in the following table:

* Berlin, 1894. Ernst Siegfried Mittler und Sohn.

Target Practice with Italian 8.7 cm. gun, with shell and shrapnel, against artillery and Infantry targets, war conditions, 1882.

DISTANCE		SHOT		HITS		AV. PER SHOT		TARGET*
Shot sighted for Meters	True range Meters	Number	Kind	Total	Men	Hits	Men	
I. Artillery without limbers.								
1120	1167	94	Shell	211	93	2.2	1.	Open (uncovered)
1270	1200	117	Shrapnel	223	105	1.9	0.9	Covered
1780	1804	92	Shell	120	74	1.3	0.8	Behind embrasures
1780	1780	103	Shrapnel	289	132	2.8	1.3	Open
2330	2340	95	"	247	123	2.6	1.4	Open
2410	2400	112	"	191	89	1.7	0.8	Covered
2445	2400	132	"	127	70	1.0	0.5	Covered
II. Infantry.								
1230	1280	102	Shrapnel	224	136	2.2	1.3	Open line, kneeling (uncovered)
1295	1200	107	"	91	64	0.9	0.6	Open line, lying down
1790	1800	116	"	590	374	5.1	3.2	In line, kneeling (uncovered)
1790	1800	114	"	823	506	7.2	4.5	In line, standing (uncovered)
1795	1805	139	"	808	521	6.8	3.7	One line kneeling, Second line standing, } Cov'r'd.
2404	2400	132	"	585	430	4.4	3.3	In thick column lying down (uncovered)
2420	2344	122	"	1500	925	12.3	7.6	In thick column standing (uncovered)
III. Cavalry.								
1825	1800	102	"	839	Horses 476	8.8	4.7	In line, (uncovered)

* The exact arrangement of these targets is not given in *Giornale d'artiglieria.*

This example selected with great care from a large number of experiments should give a realistic picture of the efficiency of the new artillery. It is not so overwhelming as the usual result, when taking a long wall as a target, would lead us to expect, and the number of hits is limited in a natural way, if the whole number of hits are not counted but only one in each man's breadth. This limitation naturally increases if the targets are separated by large spaces and conversely great width of sheaf is not of especial value, if only a single narrow target is offered to a single gun in firing position ; the real value of breadth of sheaf

lies in the fact that in an axial hit not too much is lost. One easily shoots over, if the shots are grouped too much, and therefore no statement gives an absolute representation of the efficiency, and if we obtain even moderate results in practice it is not bad shooting.

While a guarantee of good efficiency and the possibility of a large number of hits is indispensable, at the same time the various results obtained on the target ranges, where this efficiency must be proven. and an effort will be made to obtain the greatest number of hits, must be gone over with great strictness and each experiment examined with care as to its admission or rejection.

The above table shows the small efficiency of single shots from cannon, if their effect is counteracted by skillful tactical formations.

Yet the targets, with the exception of the last two against infantry in column, are chosen as unfavorable as possible, since only width of sheaf is demanded, while depth of sheaf, the peculiarly valuable property of the shrapnel, was not made the most of.

On page 51* of the book mentioned above is another example:

Firing with 8.7 cm. Ringshell against Infantry Targets.

The first target represented two companies abreast. In the numbers 1 and 2 was a firing line of 25 kneeling and 25 lying down infantry silhouettes in groups of five men each; 150 meters behind these came a support of 66 men. Each mans breadth taken as 0.6 meter; 180 meters behind the support came the main body, consisting of three targets behind each other, each target twelve men's breadth (0.6 meter). Number 3, had in the first line 18 standing and 18 kneeling infantry silhouettes, otherwise the same.

The target was more than 330 meters deep and the firing was executed against two targets, the line and the supports, since the bursting point was nearly always behind the first line.

On page 61,* are two Austrian target records made at Bruck in 1885, showing comparison between the efficiency of artillery and infantry fire.

(*a*) Firing of 100 men from the army shooting school against a fully horsed and unlimbered battery of 8 guns. The limbers and horses standing covered from direct fire, 11.3 meters behind the guns.

(*b*) Shooting of a heavy field battery of eight pieces and a very well instructed Jäger company of 210 men against half a battalion of infantry 117 m. broad and 225 m. deep.

1. Skirmish line in groups: 116 lying down silhouettes (⅓

TABLE 2.

Number.	Range Meters.	Shots.	Target.		Hits mans-breadth	Hits Total	Hits Per shot
1	1150	20	25 kneeling silhouettes		5	39	2.0
			25 lying down silhouettes		3	12	0.6
			66 men supports	Standing	32	47	2.4
			36 men main body	Standing	7	8	0.4
2	1400	20	25 kneeling silhouettes		5	58	2.9
			25 lying down silhouettes		4	6	0.3
			66 men support	Standing	28	34	1.7
			36 men main body	Standing	4	4	0.2
3	1500	40	18 standing silhouettes		13	24	0.6
			18 kneeling silhouettes		7	21	0.5
			66 men supports	Standing	42	163	4.1
			36 men main body	Standing	4	4	0.1

figures) and 57 half figures, these pushed forward as a reinforcement to the line.

Fire	Range Meters	Shots fired	HITS Total	% of shots.	In one minute	
100 shots	400	2050	488	28.8	122	Squad volleys, kneeling
4 Minutes	600	1683	170	10.1	43	Platoon volleys, standing

2. Remainder of the company, 50 half figures in a platoon behind the right wing as a reserve.

3. Battalion reserves, 230 half figures in half company columns 75 m. behind the company reserves.

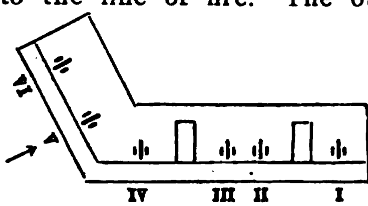
These figures show that such a disposition of troops at so short a distance before a coolly firing enemy is impossible. Tactics will therefore make the best possible use of artificial cover, and it is a question how to get at these covered troops since small arms and cannon are not sufficient. The problem falls to mortar shrapnel and torpedo shells.

Results of experiments at Krupp's works. (Lieutenant-General v. Muller page 52).

These trials took place with 12 cm. field howitzer and 12 cm. field mortar in August 1887. The target was taken to represent

FIRE	RANGE METERS	FIRED	HITS				
			Total	Per shot	Per cent of fragments	In one minute	Figures struck
Battery in six minutes	720	112 Shells	820	7.3	5.4	136.7	333
	1125	{ 4 Shells, 78 Shrapnel }	1256	16.1	8.8	209	367
	1500	{ 4 Shells, 66 Shrapnel }	462	7.	3.8	77	204
210 Jäger in three minutes	750	3011 Shots	315	—	10.4	105	174
	1125	1722 "	132	—	7.6	44	93

a sunken battery of six guns, four of which were in a line oblique to the front more than 45° while the other two were at right angles to the line of fire. The object of this arrangement was to compare a frontal and half lateral attack of a defensive work, but it did not correspond to artillery targets in pitched battles as its lines were much stronger. This experiment is more valuable than any other published account as a study of the effects of mortar shrapnel fire against covered troops, except possibly those in rifle pits, who are said to be covered to angle of fall of 30°.



Each gun had seven cannoneer silhouettes. The parapet was 2 meters high, just inside which stood silhouettes 1.8 meters high, they had cover to 22½ degrees—the men next to them were covered to 9° and 10°. In the oblique part of the battery, that is, guns 1 to 4, the men at breastworks were covered under 15°, the other men at guns 1 to 3 were protected by traverses up to 9° and 10°.

In order not to lose lateral hits, the flank guns 1 and 6 were fired at least. The results were classified as follows:

(*a*) Number of men hit.

(*b*) Hits in same.

(*c*) Hits in battery, between men and four meters behind them.

(*d*) Hits in targets at breast height.

First.—Firing with 12 cm. howitzer August 1887. Shrapnel from 16.3 kg. to 16.5 kg. in weight filled, with 460 hard lead balls of 16 grammes weight or with 285 balls of 26 grammes, with a bursting charge of from 200 to 215 grammes of powder. The initial velocity with the 0.5 kg. coarse grained powder of $\frac{6}{10}$ mm. granulation was 140 meters; with 0.6 kg. 161 meters; with 1 kg.

225 meters; with 1.5 kg. 290 meters, giving by accident the velocity of the shell from the Prussian 9 cm. gun of 1864.

Distance of bursting point measured from inner edge of breast works perpendicular to line of fire.

Firing at 1500 Meters.

Charge.	Number.	Weight of Balls.	Elevation.	Allowance.	Length of Fuze.	Bursting Point. Over or Short.	Bursting Point. High		HITS ON GUNS.							
Kg.	No.	G.	Deg.	P't.	Sec.	m.	m.		1	2	3	4	5	6	Total.	Total in Battery.
	1	16	22.5	22	11	—40	16	a	3	1	2	5	6	—	17	77
								b	3	2	2	5	9	—	21	
								c	7	5	7	10	13	—	42	
								d	—	—	2	4	8	—	14	
	2	16	22.5	25	11	—60	15	a	—	1	—	2	4	1	8	34
								b	—	1	—	3	5	4	13	
								c	—	2	2	6	5	3	18	
								d	—	—	1	1	1	—	3	
0.5	3	26	22.5	22	11	—50	14	a	1	—	2	2	—	1	6	41
								b	1	—	2	4	—	1	8	
								c	2	4	3	12	5	—	26	
								d	—	—	—	5	1	1	7	
	4	26	22.5	22	11	—45	11	a	—	1	—	—	—	—	1	12
								b	—	1	—	—	—	—	1	
								c	—	1	—	3	1	2	7	
								d	—	1	3	—	—	—	4	
	5	26	22.5	25	11	—60	14	a	—	1	2	4	4	—	11	33
								b	—	1	2	5	4	—	12	
								c	—	1	3	9	7	—	20	
								d	—	—	—	1	—	—	1	
	6	26	8.6	8	6.5	—160	16	a	—	—	1	1	3	—	5	10
								b	—	—	1	1	5	—	7	
								c	—	—	—	1	2	—	3	
								d	—	—	—	--	—	—	—	
	7	26	8.8	8	7.0	—60	11	a	—	—	—	—	—	3	3	4
								b	—	—	—	—	—	3	3	
								c	—	—	—	—	—	1	1	
								d	—	—	—	—	—	—	—	
1.0	8	26	8.7	0	7.2	—25	4	a	—	—	3	3	2	1	9	41
								b	--	—	4	8	6	1	19	
								c	—	1	3	10	5	—	19	
								d	—	—	—	3	—	—	3	
	9	16	8.7	0	7.1	—40	8	a	—	1	3	6	2	—	12	54
								b	—	1	3	8	5	—	17	
								c	—	2	3	20	5	—	30	
								d	—	—	—	7	—	—	7	
	10	16	8.7	0	7.1	—45	8	a	—	—	2	5	4	—	11	55
								b	—	—	2	17	6	—	25	
								c	—	5	6	5	3	—	19	
								d	—	—	—	10	1	—	11	

At 1500 meters with 0.5 kg. charge, 43 cannoneers and 29 men at the breastworks were placed *hors de combat* in five shots; with the heavy charge of 1.0 kg., 40 cannoneers and 21 men at the breastworks were put out in five shots. The battery received 197 and 164 balls.

Table B. Firing at 1980 Meters.

Charge.	Number.	Weight of Balls.	Elevation.	Allowance.	Length of Fuze.	Bursting Point. Over or Short.	Bursting Point. High.		Hits on Guns. 1	2	3	4	5	6	Total.	Total in Battery.
kg.	No.	G.	Deg.	P't.	Sec.	m.	m.									
								a								
	11	16	25.1	25	13.5	—50	0	b	Too short.							
								c								
								d								
								a								
	12	16	26.3	25	13.5	—60	23	b	Right, over. 88 at 33 distant.							
								c								
								d								
								a	1	2	—	1	—	—	4	
	13	16	26.3	40	13.5	—60	25	b	1	2	—	1	—	—	4	15
								c	2	3	5	1	—	—	11	
								d	—	—	—	—	—	—	—	
								a	—	1	—	—	—	3	4	
0.6	14	16	26.1	50	13.5	—35	6	b	—	2	—	—	—	4	6	7
								c	—	—	—	1	—	—	1	
								d	—	—	—	—	—	—	—	
								a	1	—	3	1	—	—	5	
	15	16	25.4	30	13.4	—50	8	b	1	—	4	1	—	—	6	32
								c	9	8	6	1	1	—	25	
								d	—	—	1	—	—	—	1	
								a	—	1	1	6	5	—	13	
	16	26	25.4	35	13.4	—60	18	b	—	1	1	7	8	—	17	38
								c	—	—	3	5	9	1	18	
								d	—	—	—	1	2	—	3	
								a	—	1	1	4	7	—	13	
	17	26	25.4	40	13.4	—25	9	b	—	1	1	7	30	—	39	126
								c	—	—	5	24	43	—	72	
								d	—	1	—	4	10	—	15	
								a	—	—	—	2	2	3	7	
	18	26	25.4	40	13.4	—40	18	b	—	—	—	2	4	3	9	43
								c	1	4	—	8	7	9	29	
								d	—	—	—	1	4	—	5	
								a	2	1	1	2	—	—	6	
	19	16	12.1	12.0	9.3	—90	14	b	3	2	1	3	—	—	9	10
								c	—	—	—	1	—	—	1	
								d	—	—	—	—	—	—	—	
								a	—	—	3	5	5	—	13	
1.0	20	16	12.1	12.0	9.5	—55	13	b	—	—	4	13	6	—	23	49
								c	—	3	4	11	8	—	26	
								d	—	—	—	—	—	—	—	
								a	—	1	—	1	2	—	4	
	21	26	12.0	12.0	9.5	—10	5	b	—	1	—	1	2	—	4	19
								c	—	—	—	8	7	—	15	
								d	—	—	—	—	—	—	—	
								a	—	—	—	—	4	—	4	
	22	26	12.0	12.0	9.5	—2	0	b	—	—	—	—	58	—	58	137
								c	—	—	—	—	79	—	79	
								d	—	—	—	—	—	—	—	

In firing at 1980 meters the smaller change of 0.6 kg. 46 cannoneers and 24 at the breastworks were put out in six shots; with

Table A. Firing at 1500 Meters.

Charge. kg.	Number. No.	Elevation. Deg.	Allowance. P't.	Length of Fuze. Sec.	Bursting Point. Over or Short. m.	Bursting Point. High. m.		Hits on Guns. 1	2	3	4	5	6	Total.	Total in Battery.
0.75	1	25.3	25	11.6	—75	22	a	—	3	1	2	3	3	12	45
							b	—	3	1	2	3	3	12	
							c	—	3	7	3	6	10	29	
							d	—	—	1	3	—	—	4	
	2	25.3	25	11.6	—55	20	a	—	2	4	3	3	—	12	65
							b	—	2	5	3	3	—	13	
							c	9	5	9	9	6	1	39	
							d	1	2	5	3	2	—	13	
	3	24.8	25	11.6	—60	16	a	1	1	2	—	1	—	5	56
							b	3	1	2	—	1	—	7	
							c	11	8	6	5	7	2	39	
							d	1	2	4	—	3	—	10	
	4	24.8	25	11.6	—60	14	a	—	1	2	2	1	—	6	21
							b	—	1	3	2	1	—	7	
							c	4	1	3	4	1	—	13	
							d	—	—	1	—	—	—	1	
	5	24.8	25	11.6	—70	16	a	2	—	1	6	1	—	10	46
							b	2	—	1	9	2	—	14	
							c	4	4	3	9	4	—	24	
							d	—	—	—	7	1	—	8	

Table B. Firing at 1975 Meters.

Charge. kg.	Number. No.	Elevation. Deg.	Allowance. P't.	Length of Fuze. Sec.	Bursting Point. Over or Short. m.	Bursting Point. High. m.		Hits on Guns. 1	2	3	4	5	6	Total.	Total in Battery.
1.0	6	23	30	12.7	—75	18	a	—	1	1	4	1	3	10	68
							b	—	2	1	5	1	3	12	
							c	2	7	6	14	10	8	47	
							d	—	—	—	4	3	2	9	
	7	23	25	12.7	—80	20	a	—	2	1	2	3	2	10	68
							b	—	2	3	3	3	2	13	
							c	2	9	10	8	10	10	49	
							d	—	2	2	2	—	—	6	
	8	23	25	12.7	—70	22	a	1	1	3	—	—	—	5	42
							b	1	1	3	—	—	—	5	
							c	4	9	7	10	3	3	36	
							d	—	—	—	1	—	—	1	
	9	22.8	25	12.7	—65	16	a	—	3	3	5	3	—	14	67
							b	—	4	5	7	4	—	20	
							c	5	7	12	11	5	—	40	
							d	—	—	1	4	2	—	7	
	10	22.8	25	12.7	—75	18	a	1	3	5	2	—	3	14	69
							b	1	3	7	3	—	3	17	
							c	8	13	9	9	5	2	46	
							d	—	1	3	2	—	—	6	
	11	22.8	25	12.7	—55	14	a	6	5	3	5	5	—	24	88
							b	6	5	5	7	8	—	31	
							c	10	11	12	5	8	—	46	
							d	1	1	3	4	2	—	11	

the larger charge of 1.0 kg. 27 cannoneers and no men at breastworks were put out in four shots. The battery received 261 and 215 shots and in addition a gun was disabled.

Second.—Firing with the 15 cm. mortar August, 1887. The

shrapnel weighed from 31.53 kg. to 31.75 kg. and contained 500 hard lead balls of 26 grms. Bursting charge between 310 and 410 gm. Initial velocity with 0.75 charge 135 m.; with 0.9 kg. 153 meters; 1.0 kg. 163 meters; with 1.5 kg. 210 meters.

Table *A*. Firing at 1500 meters.

Table *B*. Firing at 1975 meters.

At 1500 meters with the smaller charge 45 cannoneers and 36 riflemen put *hors de combat* in five shots, and at 1975 meters with the larger charge of 1.0 kg. 77 cannoneers and 40 riflemen in six shots. The battery received at 1500 meters, 233 and at 1975 meters, 402 balls.

These results of the efficiency of the high angle guns demand careful consideration when taken in connection with the results of the cannon given above. It can be seen in the above firing that to shoot at a target of such little depth is entirely against the nature of shrapnel, in so much as breadth and not depth of sheaf will be effective, and consequently in the best firing, about a fourth of the balls fall in front of the battery, a fourth into the battery, and a half beyond it, or a fourth in it and three-fourths beyond it.

[Translated by First Lieutenant E. S. BENTON, 1st Artillery.]

HOWITZERS AND MORTARS FOR FIELD ARTILLERY, TO SUPPLY A NEED OF CURVED FIRE.

By Tiedemann, Major and *Abteilungs-Kommandeur* in the Posen Field Artillery Regiment, No. 20.

Jahrbücher für die deutsche Armee und Marine, November, 1897.

B. Measures adopted during the present decade as a result of the foregoing considerations.

I. GENERAL VIEW.

The experience of the Russians, especially at Plevna, as to the inadequacy of their light artillery gave rise to a general endeavor to make up the deficiency. It was remarked on all hands that unless something was done in this line, a war in the future would probably be unusually prolonged, since a considerably inferior force by throwing up intrenchments could hold a much larger force at bay, and keep it from engaging in a decisive campaign.

When rifled guns had first been adopted, many States, as France, Austria and Germany, had retained reduced charges for the new guns, in order also to be able to use them after the fashion of howitzers. But this had to be given over, for the small charges burning ununiformily in relatively large powder chambers gave variable initial velocities to the projectile. Besides this, the twist of the rifling of the field guns was too small for the initial velocities that were attained, so that the stability of the axis of rotation of the elongated projectiles suffered. As a consequence of both these defects, projectiles thus fired went wild, and hence reduced charges were abandoned.

When at Plevna it again became a question of reaching targets protected against the angle of fall of flat trajectories, recourse was once more had to reduced charges, hoping thereby to preserve that simplicity in the artillery system which is so necessary for an army in the field. The attempts to obtain this end by shrapnel at high angles proved fruitless though long continued (1886-1888). The point of burst of the shrapnel was very variable, and as a consequence the effect against targets protected against

15° to 22° was extremely small. With protection against 15° fall, under favorable conditions, and after a large number of rounds, from $\frac{1}{7}$ to $\frac{1}{4}$ of the targets used were struck. On an average one-half a bullet hit for each round. The firing consumed much time, as the rate of fire was slow, and observation of the shots difficult on account of the little amount of smoke from the bursting shrapnel. Since no tactical effect in the field was to be hoped for (the tests agreeing with calculation) the trials were abandoned. The impossibility of thus solving the problem was shown by Rohne, then Lieutenant-Colonel, in a paper published in 1887, entitled. "What may field artillery expect from the use of reduced charges?" (*Archiv für die Artillerie und Ingenieur Offiziere. 94. Band*). The author at the same time proposed the employment of field howitzers or mortars for seeking out concealed targets.

There remained now but two ways to compass the desired end ; one was to use howitzers and mortars in light artillery, the other was to use projectiles which, though carrying a bursting charge, could be fired at light initial velocities along a flat trajectory, and be able to hit concealed targets by the disposition of the bursting charge.

II. RUSSIA.

The Russians who felt so keenly the insufficiency of their field guns in the war of 1877-78, and who learnt at Plevna the value of field intrenchments for the defense, have since adopted field mortars for their field army.

They have now 24 batteries of field mortars, with six pieces to a battery. The batteries are organized into five regiments of four batteries each, and two regiments of two batteries each. As the first two regiments were created in 1889 and the number of regiments has been increased year by year, it does not look as if the limit were yet reached. This seems the more likely as regiments number 6 and 7 contain but two batteries apiece, whereas if 24 regiments had been considered sufficient for the army, it seems probable that but a single sixth regiment would have been created having four batteries, as the other five regiments have.

The regiments first organized were assigned to the military districts of Wilna and Kiew.

The strength of a regiment is as follows (the battery being shown in parenthesis) :

Officers.	Men.	Horses.	Pieces.	Ammunition Carts.	Caissons.	Supply Wagons.	Other Vehicles.
Peace 25 (4)	689 (52	261	24 (6)	24	72	4	43
War 25 (4)	862 (109)	756	24 (6)	24	72	4	44

Besides the large number of 18 caissons each mortar battery has 6 ammunition carts drawn by a single horse. The gun carriages have six horses, the other wagons four. The regimental wagons consist of 6 one-horse vehicles (3 officers' carts, 2 apothecary and one hospital cart); 31 two-horse vehicles (3 regimental pack wagons, 12 regimental artillery supply wagons); 1 three-horse vehicle (headquarter wagon); and 6 four-horse vehicles (2 ambulances, 4 battery tool wagons).

The total weight of a fully equipped mortar without connoneers is 2100 kg. (4620 lbs.), or 350 kg. (770 lbs.) per horse; this is greater than that of the German field gun. The limber carries twelve projectiles, the ammunition cart four, the caisson twenty-eight.

The ammunition cart is for bringing up ammunition to the battery from the ammunition park. The employment of this intermediary seems to indicate that the caisson is too heavily loaded for four horses, to be certain of moving across fields. For each mortar, there are 92 rounds provided in the battery, so that the total ammunition supply of a battery amounts to 552 rounds. The projectiles, shrapnel and torpedo shell, lie in hand barrows which are used in loading them into the caisson; special boxes for transportation are also used for the powder charges.

The mortar is of steel, 15.24 (6 in.) caliber, wedge lock and oblique vent. It is 9 calibers long, with bore 7 calibers long: weight, 460 kg. (1012 lbs.). The tube and jacket are connected by a locking ring; the piece has no preponderance. On the face of the right trunnion is a rack for giving elevation. The shrapnel weighs 31 kg. (68.2 lbs.), with steel body which is thicker towards the base. The bursting charge weighing 247 g. (8.7 oz.) is situated in the base contained in a steel cup with rim towards the base of the projectile. From this cup runs an iron tube connecting through an orifice with the combination fuze. The shrapnel contains 720 balls of hard lead in a sulphur matrix. The fuze burns 28 seconds. The projectile has two copper rotation bands.

The torpedo shell is of steel weighing 26 kg. (57.2 lbs.), with a bursting charge of 4.88 kg. (10.7 lbs.). It has but the percussion fuze, and one centering and one rotation band.

Three powder charges are at present used, consisting of coarse grained powder; their weights are 1.74 kg. (3.8 lbs.), 0.87 kg. (1.9 lbs.) and 0.435 kg. (.96 lbs.). The largest of these charges imparts to the shrapnel an initial velocity of 220 m. (721 feet), to the torpedo shell an initial velocity of 232 m. (760 feet); the maximum range is 3200 m. (3500 yards).

The cylindrical body of the shrapnel is not broken up when its charge explodes, so that the bullets and head are projected as from a small mortar. Their velocity is increased by the bursting charge, but the lateral distribution is not great. The difference in weight of the two species of projectile is not practical as it requires a separate range table for each.

The carriage consists of the chassis, the steel axle with rubber springs, the wheels and the support. The cheeks of the chassis are of sheet-iron, and approach each other towards the trail, being held apart and in place by iron transoms. The trunnion beds are made especially strong that the cheeks may withstand the great thrust. A worm engaging in the segmental rack on the right trunnion gives the elevation.

The steel axle lies forward on the chassis; the cheeks of the chassis have a motion downward on the axle, and are connected through bolts with the axle buffers, which consist of six caoutchouc disks with iron disks between. Upon firing the cheeks press downwards on the axle, and the thrust from the powder gases is thence communicated to the supports, which are raised during transportation but let down when firing begins. These supports are provided with buffer disks and rest on the ground. By these means the axle and wheels are as far as possible relieved from the great downward blow on firing.

The gun in firing is 1.1 m. (3½ feet) from the ground, this permitting elevations from $+47°$ to $-18°$.

The Russian reports of comparative tests in 1891 between mortars and field guns are very instructive. According to these reports, at ranges of 1500 to 2300 m., the mortars firing shrapnel were far superior to the field guns against targets representing cannoneers behind the parapets of a field work. A further bombardment of the work by mortars firing torpedo shell at 1800 m. made an easily practicable breach through parapet and over trench. The havoc in the works was of such a character that it is not likely the garrison could have held the position to the end of

the infantry attack. The blindages constructed in the trenches behind the parapets were likewise unable to withstand the force of the torpedo shells. In another trial with the Russian 15 cm. (5.9 in.) field mortar against targets protected against the flat trajectory of field guns, 112 out of 225 of the silhouettes were hit at a range of 2500 meters in 108 rounds (62 shell, 46 shrapnel). The number of bullets that struck as well as the exact angle against which the targets were protected is not stated. In another trial, at 1650 meters with 115 rounds (70 shell, 45 shrapnel), 180 silhouettes out of 225 were struck; of these 180, there were 86 not behind cover.

To still further try the question whether a mortar battery might fight a field gun battery in the open, comparative trials were made with these two species of cannon at 2100 meters range. Firing at an unprotected battery with 112 targets, 56 targets were struck by the field guns after 74 rounds, with 346 bullets hitting; at the same targets the mortar battery struck 109 of the figures after 65 rounds, with 2668 bullets hitting.

This result which at first glance is decidedly in favor of the mortar battery is not, however, entirely free from objection. Both batteries should have been permitted to fire for the same length of time. Had this been done, the ratio of the number of rounds delivered would have been for the field guns relative to the mortars as 5 to 1, making a far more favorable case for the field battery. The mortars with this condition would have fired, let us say, fifteen rounds, with a probability of 27 figures struck, and 600 bullets hitting.

Calculatiing the weight of ammunition expended by field guns and mortars, and using the figures of the actual firing, we find for the field guns for 1 kilogram of iron expended, 0.09 target struck with 0.59 bullet hitting; for the mortars, on the other hand, for 1 kg. of iron expended, we find 0.05 target struck with 1.02 bullet hitting. The case thus stands more favorably for the field battery with respect to the number of cannoneers hit, even were the mortar battery able to deliver 65 rounds in the same time that the field battery fired 74 rounds.

Lieutenant-General Engelhardt, of the Russian service, who has given much attention to mortar construction, has declared, perhaps with a touch of optimism, that the question of field mortars has been best solved in Russia. Their mobility has been proved in the Rowno maneuvers; when marching with the Cossacks, they have never been left behind. This good mobility has been attained in spite of the large calibers, which have the

advantage of the large number of shrapnel bullets to each projectile.

That there is a difference of opinion in Russia respecting field mortars is to be inferred from the following sentences in a paper by General Engelhardt: "A discussion of the advisability of substituting the 12 cm. (4.7 in.) for the 15 cm. (5.9 in.) mortar is unseasonable; for our mortar in spite of its large caliber is the lightest. It has nearly every advantage. To be sure it has one defect that its maximum range is but 3200 m. while other countries have pieces of equal caliber firing 5 kilometers; but this can be remedied by using smokeless powder with some necessary changes in consequence in the carriage. Were this done, our mortars would be superior to those of other states."

The General is thus of the opinion that the field mortar must be a long range cannon, and indeed thinks that it will frequently be the case that it can be used only at long distances. But this requisite the present model by no means fulfills. If a mortar battery can find no cover and must contend with a field battery, the calculation made above of the hits per kilogram of iron shows clearly that it must do so at a disadvantage. From this arises the demand that the mortar shall have a range up to 5 km., a condition that the Russian mortar to the present time has been far from satisfying.

General Engelhardt is of opinion that thanks to the employment of the ammunition carts, the conveyance of the heavy projectiles from the ammunition park to the guns is now assured. The use of these carts seems to indicate that the four-horse caissons lack mobility; the assignment of six ammunition carts to six pieces evidently means that each piece will have its ammunition brought up by one cart. The first round will be taken from the six limbers. While this round is loading, four of the limbers will return to the ammunition park, and the other two stay with the pieces (numbers 2 and 5). The carts each carrying four rounds will now come up and take a position behind the pieces, and furnish the four following rounds for each mortar. At the rates of one shot a minute per battery and two per minute, the carts will be empty in 24 and 12 minutes respectively; when this occurs, the carts return to the ammunition park, are again loaded, and return once more to the guns. During their absence the mortars draw their ammunition from the two limbers that remained by them, and these when empty are replaced by two full limbers. In any case, even though the method of supplying

ammunition may not be just as outlined here, the continual coming and going of the carts in moderately open country will not remain unnoticed, but will assist in discovering the position of the battery when it is otherwise concealed.

From all the facts relative to the Russian field mortars the following conclusions may be drawn respecting their employment:

1. The mortar batteries are deficient in mobility. Many opinions agree in this; the mortar batteries have blocked the way of the other troops, and of course, in this connection, it is of no moment whether it was the pieces or the ammunition wagons that constituted the hindrance. All the parts of a field battery must be equally mobile. With the Russian caissons this evil might be corrected by using six horses.

2. The batteries with their great number of vehicles take up so much space in the column of march, that it becomes necessary to place them in the rear, that the other troops may be brought into action seasonably.

3. At the beginning of the artillery duel, the mortar batteries will not be able to participate on the grounds stated in 1 and 2, as well as for the reason that the artillery contest will probably open at ranges too great for the mortars, or at which their inaccuracy will be excessive.

4. On account of their marked inferiority in rate of fire, the mortars will not dare to engage with field guns, since the mortars must inevitably be worsted, unless they are concealed or protected. Besides the mortar battery consumes from eight to ten minutes between unlimbering and firing of the first shot.

5. The manner of bringing up the ammunition requires a position for the mortar batteries concealed from the enemy's view.

6. The long time between unlimbering and the first shot (and this evidently will not be less in limbering up) requires likewise a concealed position.

It seems probable therefore that in a battle, these batteries will only come late into play, when the field gun batteries have slackened after a long duel, and shelter trenches are to be bombarded before the decisive infantry attack. It would be a wasteful and improper use of the limited, and not easily replaced, ammunition of the mortars, to use it against such targets as could equally well be bombarded by field guns. On the march therefore the mortar batteries belong to the rear of the column, in an engagement they are at first with the reserve, and do not come into action until the place is fixed against which the main attack

is to be made. Against this point the mortars open from concealed positions, supported by the field guns which unite their fire against the same objective.

Their employment as light siege batteries seems also to be had in view; the Russian army would thus have at hand 144 of these mortars for siege purposes.

III. FRANCE.

After France had fortified her eastern frontier after 1870, the first steps taken were with a view to the defensive in the event of a new war with Germany; at times, however, consideration was also given to the idea of assuming the offensive and besieging the enemy's fortified places. The rapid mobilization in Germany made the French look to the defensive as their part; on the other hand the confidence the French had in having created a stronger army encouraged them in the idea of taking the offensive,

So Russia's example has been followed, and a curved fire gun has been introduced into the field army, in this case a 12 cm. (4.72 in.) howitzer. The number of these batteries is not known, but they have been assigned to several of the Army Corps in divisions of two batteries each. The battery consists of 6 howitzers, 9 caissons, one field forge, one provision wagon, drawn by six horses; there are also in each battery one luggage and one forage cart, each drawn by two horses. The limber carries 16 shrapnel; four of the caissons carry shrapnel, and the other five shell. As the body of each caisson holds 32 rounds, each battery is supplied in all with 288 rounds of shrapnel and 240 rounds of shell. This makes 88 rounds for each howitzer. The ammunition column for each division carries in addition 800 rounds, with the same ratio of shrapnel and shell as in the battery. The projectiles are stowed in two layers, with the powder cartridges above in chests.

The carriage of the 12 cm. howitzer consists of an upper and lower part. The piece is of steel, 14 calibers long, surrounded by a jacket on which are the trunnions supporting the piece on the carriage. Parallel and under the piece is a bronze cylinder with a hydraulic recoil apparatus. This cylinder connects with an air chamber, and is joined to the piece through the locking ring; the air chamber is screwed into the jacket.

Upon discharge the piece moves back inside the jacket carrying with it the recoil cylinder, from which the oil passes through a valve and compresses the air in the air chamber. The piece is

thus brought to rest; the compressed air then expanding and forcing out the liquid returns the cylinder and with it the piece to its original position. The maximum possible recoil for the piece within the jacket is 475 mm. (1.9 ft.).

The piece itself weighs 550 kg. (1210 lbs.), jacket and recoil check together 140 kg. (308 lbs.), the carriage 785 kg. (1727 lbs.), and the limber (1958 lbs.), so that the total weight of the howitzer without the cannoneers mounted upon it is 2365 kg. (about 5200 lbs.). Without cannoneers therefore it is as heavy as the German field gun carrying them.

The recoil cylinder, which considerably augments the weight of the piece, is intended to return the gun to its original position, so that the howitzer may be used as a species of rapid fire cannon. It looks as if this portion of the piece was very easily susceptible of derangement, for though according to French accounts the cylinder needs refilling only after 1500 rounds, there are nevertheless two precaution arranged to permit a continual observation of the state of the cylinder. First of all a pin is placed 420 mm. (16.5 in.) from the front end of the jacket, along the path of the tube. If the piece recoils in the jacket more than this it breaks or bends the pins. The fire may however be kept up until the recoil is stopped by a ring of rubber buffers about the tube. By means of this ring the tube is prevented from breaking through the rear of the jacket when the recoil apparatus is rendered unserviceable in the course of firing or damaged by the enemy's projectiles.

The lower part of the carriage has wheels 1.36 m. (4½ ft.) in diameter, a wheel tire brake for use during transportation and a prong attached to the trail to take up the recoil on firing. When the piece is limbered up this prong is only 37 cm. (14½ in.) from the surfase of the ground, so that it can easily be struck in passing over broken ground and cause injury. When firing the prong sinks firmly into the earth and takes up the recoil gradually. The recoil cylinder serves to lessen the shock, which would be very great were the recoil entirely arrested, and would heavily tax the carriage.

The use of the prong making it difficult to alter the direction of the carriage; the upper part of the carriage is pivoted on the lower part, so that the fire may be rapidly distributed along the objective. The howitzer can thus be traversed 5½° to either side, the motion being given by a crank wheel and toothed arc. Elevation is given through a toothed arc on the right trunnion. In transportation the top carriage is secured firmly to the lower part.

The rate of fire is usually 3 rounds per minute, with six rounds per minute for rapid fire. This rather slow rate of fire, which was not to be expected from the character of the carriage, is due to the construction of the howitzer. The breech mechanism requires that the muzzle be depressed for loading so that the elevation of the axis of the bore shall not exceed 7°. As such small elevations are not usual in howitzer firing, time is necessarily consumed in sinking and raising the muzzle.

In addition, the recoil cylinder must be observed after each round. Nor is there any security against premature discharge, or a too early opening of the breech. This last is important because French powder sometimes flashes up again when the breech is rapidly opened. The nature of the breech mechanism (screw fermeture) likewise makes rapid fire impossible as it demands a constant observation of the plastic gas check.

The height of the trunnions is 1.1 m. (3.6 ft.); the elevation possible for the howitxer reaches from $-5°$ to $+45°$.

The shrapnel is of steel, with a chamber at the base and one in the head. The rotation band is of copper, the bursting charge is 280 g. (10 oz.) of small arm powder, and the filling is 670 balls of hardened lead weighing 12 g. ($\frac{3}{7}$ oz.). The fuze is a combination one. The weight of the shrapnel is the same as that of the shell 20.35 kg. (45 lbs.). The shell is four calibers long (*obus allongé*); it is made of steel with thin walls, carries 6 kg. (13 lbs.) melinite, and has only the percussion fuze. It is designed for use against objects with considerable resistance. Far less effect is expected from the faagments of the shell upon explosion, which are but a few strips, than from the enormous compression of the air resulting from the detonation, which is certain to cause serious internal injury to every one around if the shell bursts in a confined space. It is not yet known how great its sphere of action is, but there can be no doubt that this projectile will have a terrible effect on the nerves. The melinite shell will undoubtedly be very effective if it strikes near the target; it will be of especial value against earth-works, and for overthrowing weak stone walls by the air stress, as well as for breaking through stronger wooden defences.

Of course there is a possibility of the shell exploding in the bore, which would destroy the gun and kill all in the vicinity. The chances of such an accident, it is true, have been much reduced by a care in the construction of the projectile, and besides this the initial velocity of the projectile of a howitzer is always

small. There is a further security against premature detonation in the exclusive use of the percussion fuze.

The cartridges are in the form of four sided prisms containing 220 and 330 g. (8 and 12 oz.) of smokeless powder, and give by putting them together the maximum charge 550 g. The calculated initial velocities for these three charges are respectively 173, 217 and 290 m. (567, 712, 951 ft.); using percussion fuzes the maximum ranges are 2600, 3800, and 6000 meters; using time fuzes with a maximum time of burning of 22 seconds, 2600, 3450 and 4850 meters.

The two smaller charges, which together make the service charge, are put up in bags of different colors, so as not to get them confused when they are used separately. To make the conditions of loading uniform when only one cartridge is used, and thus avoid variation in the powder pressures, a paper cylinder of the same length as the cartridge omitted is inserted in the mouth of the cartridge used.

The limber of the 12 cm. howitzer is similar to that of the French 9 cm. field gun. The door of the limber chest opens backwards and rests upon the rear foot board for the cannoneers. The projectiles lie in two rows over one another in prepared spaces; projectile cases are not therefore employed. The cartridges lie on top in sacks containing eight apiece; here also are the fuzes, and compartments for other accessories. The opened door of the limber chest serves as a table to hold the small cartridges.

There is some difference in the accounts as to the distribution of the cannoneers in transportation. According to one account two men are carried on the axle seats of the carriage, two on the limber, and two on the caisson limber; another account says that five men are carried on the limber of the piece, and when necessary even six. For the service of the howitzer, a gunner and six men are required, three are for the service proper, three bring up ammunition, and one looks after the ammunition and properly proportions it.

Three of the caissons filled with shrapnel take their place behind the howitzers when these are disposed for action; the limbers are kept under cover. A caisson with melinite shell may replace one of the shrapnel caissons. The interval between howitzers in position is 13 m. (14 yds.), but this may be reduced according to the nature of the country to 4 m. (4½ yds.). As the number of howitzers is limited, this close order seems to mean that the howitzers are habitually to take up a covered position,

and thus withdraw from the direct fire of the hostile field guns.

The manner of firing the howitzers is similar to that of the field guns.

The elevation is generally given by means of a quadrant on the jacket, which remains in place even while firing. A sight is also provided, but cannot be used for elevations greater than 13°; it will be used for rapid fire in the first line. A crank for changing the elevation rapidly alters the elevation by 4°. The gun may be laid in azimuth by the sight or by a plumb line, or by a rule laid against the left trunnion. This last has a spirit level attached to indicate difference in level in the wheels; it has a shorter line of sight but a greater horizontal field than the sight, and can be used at all elevations, and during the loading of the piece.

Batteries equipped with the 12cm. howitzers have their men instructed in the service of the field gun as well as of the howitzer. In artillery regiments not containing howitzer batteries, the men will nevertheless be instructed in the service of this piece in the second year of their enlistment. It is thus the intention to attach the howitzer batteries to the field artillery regiments, though all the regiments do not contain such batteries.

Data of firing tests of these guns have not been published, That they have been criticized unfavorably in certain circles is not conclusive against them, for many were dissatisfied with rifled guns when first introduced.

From the facts that we do know, we can conclude that the howitzer has a good deal longer range than the Russian 15 cm. mortar. The shrapnel of the French piece which contains nearly as many bullets as the Russian will be almost as effective; the melinite shell is much better than the corresponding Russian shell.

Among the defects of the piece may be mentioned that it is too heavy for covering long distances on the field (the piece with five cannoneers weighs 2755 kg. (6060 lbs.) and the caisson about the same); other defects are that the recoil cylinder is easily injured; that a blow from the gun on the jacket may disable the piece; that the prong increases the weight of the trail, impeding the limbering up, and also makes any considerable change in direction difficult. Moreover the fermeture, together with the position of the bore in loading, and the absence of a graduation for range on the sight, makes rapid fire out of the question. The piece is indeed of excellent construction, but very complicated.

The howitzer batteries for these reasons will probably seek covered positions when engaging in the artillery duel at medium ranges, yet they will be able to take part in this contest from the

long ranges at the very start. The large amount of shrapnel allotted them points to their employment in the artillery duel. When the enemy seeks cover from the field guns behind works of high profile, the howitzers will probably use the melinite shell to destroy the earthworks and kill those in the neighborhood of its burst. On account of the small depth of such targets the howitzers will probably push forward to medium ranges to attain accuracy and in so doing will take cover to escape the field guns.

In spite of the prong the recoil is not entirely checked, for in certain trials in yielding ground (and this must generally be reckoned on), the recoil amounted to 96 cm. (38 in.) for the first round, 40 (16 in.) for the second, and 28 (11 in.) for the third. In the last, the trail sunk into the ground.

According to the "Regulations for the service of the artillery in the field," the howitzer divisions will be assigned to the separate armies according to the army's task. It is optional with the commander of the army either to attach them to a corps, or to keep them under his personal orders.

IV. OTHER FOREIGN COUNTRIES.

In other countries within and outside of Europe, the example of Russia and France has been followed, and mortars and howitzers have either already been introduced into the field service, or steps have been taken leading to this introduction.

Italy has adopted a 9 cm. field mortar (3.54 in.), but this cannot have much effect on covered targets.

Turkey has twelve howitzer batteries (12 cm., 4.7 in.), organized into 2 regiments each with 2 divisions of three batteries. The war footing of a battery is 4 officers, 144 men, 88 horses, 6 cannon and 14 wagons.

Japan employed field howitzers at Port Arthur, but accurate information is lacking as to the caliber or the effect produced.

Denmark has tested a 12 cm. howitzer in a field carriage, and Spain and Bulgaria have followed on the same line.

In England a 127 mm (5 in.) field howitzer has been adopted. The piece is 10 calibers long, weighs 483 kg. (1063 lbs.), has screw fermeture, plastic gas-check, and axial vent. The carriage weighs 1165 kg. (2560 lbs.), the limber with 21 rounds weighs 1120 kg. (2460 lbs.), the piece with cannoneers 2465 kg. (5420 lbs.), the caisson with 45 rounds and with cannoneers weighs 2490 kg. (5480 lbs.). The projectiles used are cast-iron shell with percussion fuze and gunpowder bursting charge, and shrapnel with base chamber, and combination fuze, and also canister;

the projectile weighs 22.7 kg. (50 lbs.). The smallest charge is 107 g. (nearly 4 oz.) of cordite. To this cartridge may be added three smaller cartridges of 72 g. each, so that there are four possible charges of 107, 179, 251, 323 g. (say 4, 6½, 9, 11½ oz.). Using the greatest of these powder charges, the initial velocity is 248 m. (815 ft.) with a maximum range of 4500 meters. The time fuze however cannot be used beyond 3100 meters. To each battery belong 6 howitzers, 9 caissons, 1 field forge (all six-horse), and six four-horse wagons.

The construction of the piece resembles that of the French howitzer. The gun lies in a bronze cradle with trunnions which support it on the carriage, and can glide for a certain distance within the cradle in the direction of the axis of the bore. Two hydraulic cylinders and two cylinders with springs return the piece to its first position after firing. The piece is fired by an obturating primer.

The carriage permits of elevations from $-5°$ to $+45°$. The latest accounts do not say whether the spade under the axle to check the recoil has been retained as formerly.

In our opinion the piece is too heavy, and the latest technical advances in gun construction have not been utilized.

Trials with a 12 cm. howitzer were made in Austria, but these have been discontinued. When curved fire is needed in the field, the Austrians propose to use the 15 cm. mortar and howitzer siege batteries that follow the army. Whether this is possible is very doubtful on account of the rapid progress of a campaign, and the weight of these cannon,—the Austrian 15 cm. howitzer weighs 1062 kg. (2336 lbs.), and the carriage is also heavier than that of the French 12 cm. howitzer. These pieces, difficult to move across country and sure to stick in wet ground, will not in action be brought at the right time to the right spot.

Switzerland in her "Position artillery" has 12 cm. mortars on field carriages, with movable platforms. The weight, 2208 kg. (4860 lbs.), is greater by 200 kg. (440 lbs.) than the German field gun. With 41° elevation the maximum powder charge (.9 kg., 2 lbs.) gives to the 18 kg. (40 lbs.) projectile an initial velocity of 285 m. (935 ft.) with a range of 4600 m. The limber carries 10 shell and 5 shrapnel, the rear carriage of the caisson three times as much. The piece is much thought of in Switzerland.

[Translated by Second Lieutenant *George Blakely*, Second Artillery.]

(TO BE CONTINUED.)

HISTORY OF THE SEA-COAST FORTIFICATIONS OF THE UNITED STATES.

V. EARLY FORTIFICATIONS AROUND NEW YORK CITY.

Reprinted from The Military Papers of Daniel D. Tompkins, Governor of New York, written during the second war with Great Britain.—Edited by Hugh Hastings, State Historian.

A GENERAL HISTORY OF THEM—SANDY HOOK AND THE NARROWS FROM EARLIEST TIMES REGARDED AS NATURAL POSITIONS FOR DEFENSE AGAINST AN APPROACHING ENEMY.

The strip of deep water, which divides the Long Island and Staten Island shores, called the Narrows, has always from earliest times been regarded as the most natural approach to Manhattan Island. Through this strait passed the "Half-moon," Hudson's eighty-ton vessel, that brought him across the sea to discover the magnificent stream that now bears and for all time will bear his name. Four years later, the first enemy that approached New York, used the Narrows, Samuel Argall, Governor of Virginia, who had destroyed the defenseless French settlements of Acadia and who now dropped in to pay his respects to the Dutch Governor, Hendrick Christiaensen. Argall demanded a surrender and Christiaensen promply complied. New York city at that time consisted of four houses, whose tenants offered no resistance to the Englishman and his armed ship.

The first record of fortifications on or around Manhatten Island is found in 1614. One or two little forts had been constructed by the Dutch, who maintained a small garrison to transact trade with the Indians. Between 1623 and 1633, the incorporated West India Company built four forts in the New Netherlands, one of which was at New Amsterdam (New York City), the other at Orange (Albany).

In 1643 complaint was made by the settlers to the State's General of the New Netherlands that Fort Amsterdam was utterly defenseless, "and stands open to the enemy night and day."

The first marked instance of the loyalty, disinterestedness and generosity of New Yorkers is found in the Colonial Records covering the year 1653. Even at that early period the budding

success of the province, due to the thrift and enterprise of her Dutch inhabitants, exited the cupidity of the Yankees of New England. The war prevailing between England, which was then under the control of Oliver Cromwell's government, and the States of Holland, gave the Puritans the opportunity to recommend that the English Protector should organize an expedition to capture New Netherland.

The English appetite for conquest, always insatiable from time out of mind, bit at the opportunity to grab the province of New Netherland and the expediton against the Dutch was ordered, the objective point being New Amsterdam. All emigrants, upon arriving in this country, had been given the strongest assurance by the Dutch West India Company of protection against the common foe. While they were expected and were willing to defend their homes againts the assualts of invaders, they had been assured, and they believed, they should not be required to work on the defenses or to render financial contributions to that end.

The dilemma in which they now found themselves was not only perilous, but threatened disaster to the province. The only alternative presented to them was to obey the behest of the Dutch Governor, Pieter Stuyvesant, or to surrender the province without a contest. No time was left for crimination, explanation or protest. The inhabitants set to work with a will to build the historical palisades or stockade from the East to the Hudson river, along what is now the northern limits of Wall street. They also aided in the construction of works of defense along the shores of the East and Hudson rivers. Nor did they stop here. With no other security than the say so of patriotic citizens, a liberal loan was raised, the home government forcing this responsibility upon the province.

The patience of the loyal people was about exhausted; and when Governor Stuyvesant served notice that the burgomasters and schepens of the city were expected to supply the fortress with provisions, in addition to all the contributions they had already made, there was open revolt. The Governor was as stubborn as they. Their demands for equity and protection were refused. In retaliation they resisted the unreasonable encroachments he had attempted upon their liberty. The outcome of the squabble would have been highly interesting, had not information arrived that as the English fleet was about to start from Boston, news had been received that peace between England and Holland was restored.

Out of this apparently insignificant episode dates the history of excise in the city of New York. The tapsters' excise on wine and beer was the source of substantial revenue to government. To meet the expenses of the city works which amounted to 16,000 florins or $6,400, computed in the currency of to-day, the citizens requested Governor Stuyvesant to transfer that amount from government's fund to the credit of the city. The testy Governor stumped with his wooden leg, ridiculed the proposition and abused the proposers. The city authorities were insistent, and in 1658 a satisfactory compromise was agreed upon, the government having yielded concessions to the city in other matters.

The English fleet that brought over Colonel Richard Nicolls in 1664 to subjugate the Dutch in New Netherland—the fleet consisting of four ships and four hundred and fifty regular troops —approached the city by the ways of Sandy Hook and the Narrows. Elkins, a Dutch governor, who came out the year after Christiaensen's submission, had thrown off all dependence on the English, with the result that the province continued under Dutch jurisdiction until Colonel Nicholls appeared on the scene. Governor Pieter Stuyvesant, who had taken office in 1647, though choleric and unbearable, was a courageous man and a determined soldier. He declared his intention to fight the English. The local authorities implored the high-strung governor to submit, and the province with all its dependencies was surrendered to the English.

The garrison retired with all their arms flying and drums beating; "and," says the chronicler, "thereby the English, without any contest or claim being before put forth by any person to it, took possession of a fort built and continually garrisoned about forty years at the expense of the West India Company."

The garrison, at the time of the surrender, consisted of one hundred and eighty soldiers, and twenty-four pieces of artillery. Pieter Stuyvesant, in his answer to the comments of the West India Company on his report on the surrender of New Netherland, describes the fort as follows:

"First. The fort is situate in an untenable place, where it was located on the first discovery of New Netherlands, for the purpose of resisting any attack of the barbarians rather than an assault of European arms, having within pistol shot, on the North and Northeasterly sides higher ground than that on which it stands, so that, notwithstanding the wall and works (muragie) are raised the highest on that side, people standing and walking on that high ground can see the soles of the feet of those on the

esplanade and bastions of the fort, where the view is not obstructed by the houses and church in it and by the gabions on the wall.

"Secondly. The fort was and is encompassed only by a slight wall, two and three feet thick, backed by coarse gravel, not above eight, nine and ten feet high in some places, in others higher, according to the fall of the ground.

"Thirdly. It is for the most part crowded all around about with buildings; better adapted for a citadel than for defense against an open enemy; the houses are, in many places, higher than the walls and bastions and render these wholly exposed; most of the houses, also, have cellars not eight rods distant from the wall of the fort, in come places not two and three feet, and at one point scarce a rod from the wall, so that whoever is master of the city can readily approach, with scaling ladders from the aforesaid houses, the wall of the fort, which is unprovided with either a wet or dry ditch; and also, if need be, run a mine from the so close adjoining cellars and blow the place up. Besides this, the fort was and is without either well or cisten."

The English remained in undisturbed possession of the province, whose name was changed from New Netherland to New York, until the 13th of August, 1673, when a Dutch squadron, consisting of nineteen ships of the line, under command of Commanders Cornelis Evertsen, Jr., and Jacob Benckes, which had arrived on the 29th of July previous, during the absence of the governor, Sir Francis Lovelace, demanded the surrender of the province, which demand was acceded to by the inhabitants on the 16th of August. The name of the province was changed to New Netherland and of the city of New York to New Orange; of the fort to Fort William Hendrick.

The triumph of the Dutch was brief, for the following year peace was established between England and the States General, of Holland, by the treaty of Westminster. Under the sixth article, England regained the province of New York, and maintained it until the final separation between the Colonies and the Mother Country.

January 20, 1664, the first mention of fortifications on Staten Island is found in the Dutch records. The Director and Council of New Netherland complain because incorrect information had been sent them, relative to the fortification or defensible condition of the mouth of the river (Hudson) both on Stated and Long Island.

The Wall street palisades which were constructed in 1653 when

war was apprehended with New England, were materially strengthened in 1673, after the recapture of the city by the Dutch, and upon the recommendation of Governor Colve, "houses, gardens and orchards" that obstructed the work were ordered to be removed.

By 1692, decay had weakened the foundations, and Governor Henry Sloughter in his speech, August 17th, reported "the fortifications are out of repair." The governor announced his intention of erecting a battery on the south point of the island, for the periodical war between England and France was threatened. He requested the citizens to lend him financial assistance.

The citizens declared that under their charter they had no authority to impose taxes upon the people for such a purpose. The governor saw otherwise. He put into practice the first inheritance tax known on the island. Estates were subjected to a tax of three pence on the pound, for the construction of the platform and battery. An additional tax of £233 was added for the purposes of defense, by the city, upon a mortgage of the ferry.

During the invasion of Canada, in 1689—1691, New York City suffered heavily. The citizens not only contributed their services in working upon the fortifications, but they cheerfully met every assessment that was levied upon them for the prosecution of the war. In 1693, by act of Assembly, £6,000 was ordered to be raised by tax; of this amount, £1,450 fell upon New York City. The city was also taxed for the construction of the fort at the battery the following year.

Under date of May 3, 1699, the Earl of Bellomont wrote to the Lords of Trade, and recommended the construction of good stone forts at Albany and "Schenectade," and repairing the fort at New York, which he estimated would cost £1,000. He said further: "'Tis wonderful to me how Colonel Fletcher could pretend to apply the greatest part of thirty pound per cent. to the repairs of this Fort and the Governor's house, when I found everything out of repair when I superseeded him. The palisadoes of this Fort are quite decayed and the larger part of them destroyed and rotting; one of the bastions crack'd through, which will fall if not speedily rebuilt; the parapet gone to decay and must be renewed; the palisados 'tis computed will cost £600 at least to be well done and the bastion £200 and the parapet £200. The roof of the house too is out of repaire so that it rains in, and the lowest floor is decayed and rotten so that I believe the repair of the house will cost near £200 more. I must not omitt to observe to your Lordships that the old part of the house is a

comfortable, convenient dwelling enough, and might have contended a Governor of a much better quality than Colonel Fletcher; and the new building will cost first and last about £5,000 New Yorke mony; so that tis plain here is so much mony consecrated to his vanity. Where all this money will be got to build and repaire Forts, I cannot tell, unless Fletcher be made to refund to the King. The Assembly here, I am almost certain, will not be brought to raise it, for I cannot prevail with 'em by any means to consent to such an additional duty as will pay the debts of the Government, which amount to upwards of £5,000."

One of the most interesting ancient military documents relating to the defenses of New York, is the report made to the Governor, the Earl of Bellomont, by Colonel W. W. Romer, whose name is perpetuated by the shoals that bear his name in New York harbor. The report is dated January 13, 1701. Colonel Romer found the distances at the Narrows between the heights on the Long Island and the Staten Island shore, to be one and one-half miles in breadth; depth of water from four to thirteen fathoms. He recommended that "there ought to be, both on Long and Staten Islands a sufficient battery with a good redoubt on each height, enclosed with proper lines of defense, communicating with the respective Batteries, and that each be furnished with 30 guns carrying 18 a 24 lbs. ball. He further recommended that a battery should be erected on Schutter's Island in the Staten Island Kills, twelve or thirteen miles from New York, to protect the town from an approach by way of Amboy. He pointed out the importance of Sandy Hook, because "reason and the Rules of War agree, that an enemy must always be kept as far off as can possibly be done, that a good blockhouse and fortification ought to be erected on the aforesaid Hook, as they would be very useful there, the channel and entrance being very narrow, and vessels on that account must pass immediately under the Hook." For these reasons he recommended "a good blockhouse and Fort of fifty guns."

"Further and lastly" he ends his report, "an enclosed battery of twelve or thirteen guns ought to be erected at the narrowest part of Hellgate, to prevent the entrance of an enemy at that point also. All this being done I am persuaded an enemy will bethink himself a hundred times before he will meditate any attack upon New York."

April, 1702, Lieutenant-Governor John Nanfan urged in his address to the Legislature, that the fortifications be "put in a good posture of defense." The following October, Lord Corn-

bury (Edward Hyde), then governor, in his speech, declared that the city and port of New York "was very much exposed."

It was not until 1703 when the British Colonies in North America were terror-stricken lest a French fleet should attack and conquer them, that the importance of erecting fortifications at the Narrows was realized. The war of the Spanish Succession was on. Leagued against France were England, Holland and their allies.

Governor Cornbury, in his address to the Assembly, of April 13, 1703, makes no effort to conceal his anxiety. He announced that he had received information that the French proposed to attack New York, by sea, the coming summer. "I think, he said, "the best way to prevent their design will be to erect two batteries of guns at the Narrows, one on each side, which I believe is the only way to make this port safe."

Three years later Governor Cornbury reproaches the people for their failure to erect the fortifications at the Narrows. The city, he declares, "lies very open, naked and defenseless." "I must take notice to you," he continued, "that the last Assembly (in 1703) did pass an act for the raising of £1500 towards erecting Batteries at the Narrows, which would have been of very great use at the time, had the money been collected; but it has not. I am sensible that some malicious, ill-minded people have reported that I had taken that money into my own hands. That the truth hereof may be known and justified, I recommend to you to make strict inquiry into that tax."

A suggestion of Washington's famous utterance "to be prepared for war is one of the most effectual means of preserving peace," is found in the speech which Governor William Cosby uttered to the Assembly, April 25, 1734: "The safety and protection of the Harbor of New York and of the frontiers, no time being so fit to guard against our future enemies as a time of peace; the duration of the present peace being uncertain."

The usual urgent plea was made for an appropriation—for the construction of a Battery in New York City, at the Point of Rocks (the Copsee battery, it was called), by Whitehall, and of new forts at Albany and Schenectady, reinforcing a suggestion that had been filed with the Lords of Trade, fourteen years before by Brigadier-General Hunter, who described the works at New York as "a fort of four regular bastions, fifty guns mounted, faced with stone, with neither fossee nor outworks."

The alarm consequent upon another expected rupture with France, persuaded Governor George Clarke to repeat the sug-

gestions of his predecessors and call attention to the city's defenselessness, April 15, 1741. He requested that batteries be erected upon the wharves facing the harbor, and that one be placed at Red Hook on Long Island to prevent the enemy from landing upon Nutten (Governor's) Island.

Again, June 25, 1745, Governor Clarke suggests to the Assembly the construction of a battery of twenty guns at the east end of the town off the harbor, "and of other batteries at other points in the town, plans for which he promised later to place before them."

With a war close at hand, Governor James De Lancey reported, October, 1753, that the Copsee Battery was in a ruinous condition. The government not only would not construct new fortifications, but refused to keep in repair those that were garrisoned. All the burdens for defensive expense, such as they were, and for the times taxes were oppressive enough, fell upon the colonists. England's policy of grab and grind was exercised not alone upon her colonists in America, but upon her dependents in India. The colonists were expected to return fabulous profits to the mother country, and to submit to the most unjust regulations and laws. The more generous the colonies, the more exacting became the demands of England.

It is not necessary to enumerate the multitudinous exactions that were made upon the colonists or to dwell upon the general and loyal compliance with which all were met. Scarcely a year passed from 1700 to the outbreak of the French and Indian war that the good-natured and much-imposed-upon colonists were not called upon to honor some extra draft drawn by England, upon their patience and their purse. The province of New York contributed £5,000 toward the Braddock campaign. The following year came the long-threatened French invasion and it cost the province £45,000 to put itself in condition to properly meet the enemy. August, 1755, the news of Braddock's crushing defeat and rout struck the colonists with terror. A £10,000 tax was at once levied upon the province, which was also compelled to maintain 400 men at Crown Point. One month later £8,000 additional were raised to be contributed for Connecticut toward the expense of sending reinforcements to Crown Point. During 1757 the province of New York raised, transported and subsisted 1,000 more men for the same expidition, but the expense thus incurred was eventually borne by the home government.

The resources of the province were stretched to the limit the

following year. Bills of credit were issued which aggregated £100,000, redeemable by payments of £12,000 in 1759 and of £11,000 in each succeeding year until the entire amount was liquidated. This generous contribution to the good cause—displaying a financial condition as sound as it was patriotic and loyal—justified the colonists in the conviction that New York was already a powerful factor in the aggregation of American colonies, and opened their eyes to certain possibilities that no doubt exerted an influence that can not be measured when the time came to break with the mother country.

In the meantime Lord Loudoun, with a large fleet, had arrived in New York in 1756, and, for the first time in its history, the city was put into proper condition for defense by land and by sea. A new line of defense, consisting of palisades, was thrown up across the island from river to river, not far from the line of the present Chambers street. The "upper barracks" was built north of the City Hall park, on what is now Chambers street, the colonists cheerfully submitting to a construction tax of £3,500; (the "lower barracks" stood on the Battery near Whitehall street, on a line with the present State street).

Upon taking possession of the city in 1776, Washington sank obstructions in the North and East rivers, and threw up fortifications to guard the narrow passages. Fort Washington was constructed near the north end of Manhattan Island, and Fort Lee on the Jersey shore opposite. Both of these were regarded as strong works. The fort at the Battery was overhauled and strengthened and a small additional battery was placed on Broadway above Bowling Green. Behind Trinity church another battery was erected on an eminence, and called McDougall's Battery, out of compliment to the patriot who constructed it. On the east side of the city two other batteries were constructed, one at the foot of Maiden lane and another at Corlear's Hook, near the present Grand street ferry.

In April, Governor's Island had been occupied by 1,000 American troops, and a couple of small batteries were hastily erected.

In Brooklyn, a line of works extended from the Wallabout, now the Navy Yard, to Red Hook. Most of the streets were barricaded and here and there in the city small works were thrown up at every vulnerable spot.

After the American army evacuated New York, the English troops constructed a number of works on the upper end of Manhattan Island, whose positions will be described later on; the small batteries on Governor's Island were strengthened and

lunettes were thrown up on the sites of the Staten Island and Long Island forts at the Narrows.

Up to the War of 1812 the States were expected to construct their own fortifications and to bear the expense, subject to whatever assistance, great or small, Congress might from time to time render. Fort Jay, on Governor's Island, was built soon after the adoption of the Federal Constitution. As far back as 1765, however, British engineers had recommended that strong works be erected on either side of the Narrows. Congress, in 1794, considered the matter of fortifying the important ports of the country. It was estimated that $12,522.36 would be necessary to construct batteries on Governor's Island and in the city of New York. Three thousand one hundred and sixty-one dollars and sixty-eight cents of this amount were to be used in fortifying Paulus Hook. At that time Fort Wood, on Bedloe's Island, had been started.

Between 1794 and 1801, Congress had appropriated $100,023.41 on the construction of Fort Jay and the smaller works on Governor's Island. It was estimated that $60,000 more would be necessary for repairs and improvements. In 1806 Fort Jay was demolished except the walled counterscarp. The construction of Fort Columbus was begun.

From the report of the Secretary of War, made by direction of the President, February 18, 1806, the following remarks are found, relative to New York harbor:

"In the year 1794 and 1795 considerable expenses were incurred in the harbor of New York, in fortifications on Governor's, Bedloe's and Ellis's Islands, and in front of the city.

"On Governor's Island, a regular enclosed work, with detached batteries for heavy cannon and mortars, was erected with a magazine and barracks, which require considerable repairs and improvements. On the other islands, there were batteries and magazines, with some barracks, which also require repairs.

"A formidable battery of heavy cannon and mortars (which is now in ruins) was erected in front of the city. A heavy park of artillery was also mounted on travelling carriages, and placed in a building belonging to the State, within the city.

"No considerable improvements have been made on the above-mentioned works, or additional fortifications erected, for the defense of the harbor of New York, within the last five years; there having been no funds for those objects furnished by the State, as contemplated by the Act of Congress of the 3rd of May, 1798, and understood to have been intended by the State.

"Engineers were employed by the Governor of the State to survey and examine the harbor, and to report the best practicable mode of defense. The report, accompanied by drawings and estimates, was transmitted to the President of the United States in the year 1801. By this project, the principal works were to be at Sandy Hook. The estimates, amounting to $3,968,658, were considered as a sufficient reason for rejecting the report; the debt of the State of New York (which was the limit of the sum anthorized to be expended) being only $1,852,035. In January, 1805, a report was also received from another engineer, accompanied by a letter from the mayor of the city, in which the Narrows were contemplated as the principal place of defense. The estimates for completing the works amounted to $2,000,000, and the plan of defense proposed inspired no confidence.

"Lieutenant-Colonel Williams, of the corps of engineers, was, last autumn, directed to make such a survey of the harbor of New York, as would enable him to report, with accuracy, the width of the Narrows, from the water's edge on each side; the distance from Governor's Island to Bedloe's, to Ellis's, and to the battery in front of the city, and from the city to the nearest point on the Jersey shore. This duty he performed, and reported, accompanying his report with a drawing of the harbor, showing the ralative situation of the several points alluded to in his instructions, with remarks on the city generally, and particularly on fortifying the Narrows."

The Secretary had this further to say:

"It will be recollected by many that in the summer of 1776 a British ship (Asia) of about forty guns had been some distance up the Hudson above New York; that it was known that she would soon pass down by that city, and the batteries were prepared at several places on the bank of the river, in and above the city, with the most sanguine expectations of destroying the ship on her passage; but, although she descended in the day time, with a moderate breeze, which afforded full time for the batteries to act on her, and a tremendous cannonade commenced from the respective batteries as she passed, no apparent injury was received by the ship; and it was generally remarked, that she appeared to be no more incommoded by the batteries than if no shot had been fired. Her distance from the batteries was about half a mile, which is little more than the distance of the center of the channel in the Narrows from any batteries which could be erected on either or both shores.

"It now remains to be decided: First. Whether the batteries

or any other points, so susceptible have been so fortified as to afford a sufficient defense to the harbor and city?

"Secondly. Whether any other practicable system of defense may be sufficiently relied upon?

"Thirdly. What general or particular system ought to be adopted?"

At every session of Congress the mode of fortifying New York was impressed with an emphasis that increased from year to year. As far back as 1806 the population, extent of resource, capital and enterprise of the city was constantly used in arguments before Congress, for appropriation for fortifications and the claim was then made that one-third of the National revenue of the capital was collected in New York City. The State had already purchased for defensive purposes the land on which the forts at Staten Island now stand. The greater part of Governor's Island also belonged to the State. During the threatening days of 1807 the Legislature of the State of New York adopted resolutions requesting "that adequate measures should be adopted by the National Government for the protection of the port of New York.

"That the agricultural as well as commercial interests of the State are deeply interested in this most desirable object.

"That in surrendering to the United States the revenue received from imposts, this State expected, and has now a right to expect, that a competent portion of that revenue would be appropriated for its defense, and that the Congress of the United States are bound by their constitutional duties, as guardians of the common defense and general welfare, to satisfy this proper and reasonable expectation."

In the report of the Secretary of War, communicated to Congress, January 6, 1809, it was stated that "the works undertaken at New York are calculated to annoy and injury any invading force which shall enter the harbor and still more one which should attempt to lie before the city. To prevent altogether the entrance of larger vessels, a line of blocks has been comtemplated, and would, as is believed, with the auxiliary means already provided, render that city safe against invading enterprise."

Fort Columbus was reported to be nearly completed, and on it fifty cannon had been mounted. Castle William was completed to the second floor, and was in shape to receive its first tier of guns which were mounted and ready to be placed. On Bedloe's Island a mortar battery covering the anchorage ground between Red Hook and Quarantine had been started, and an open barbette battery for heavy ordnance on Ellis's Island was nearly finished.

Off Hubert street, New York, 200 feet without the permanent line of the city, a battery, the North Battery, was commenced and finished that year; preparations had also been made for erecting a heavy battery on the stone foundation of the superstructure of the solid mason work at the southwest point of the city, the present Castle Garden.

December 21, 1809, Secretary of War, Eustis, reported that "Seventy-one guns were actually mounted" for the defense of New York; 150 may be actually brought into action on an emergency; and the works for the defense of the city of New York are calculated for 300 guns and 10 mortars, exclusive of those mounted on travelling carrriages, and of the works on Staten Island, erected by the State of New York, calculated for 80 guns."

Greater interest was taken in military matters during the first session of the Twelfth Congress, with the prospect of war imminent. The defenses of New York were then reported to be: Fort Columbus, mounting 60 heavy guns, brick barracks for two companies of men and officers, and a furnace for heating shot, capable pany of men and officers, 182 men.

Castle William, with 52, 42 and 32-pounders, mounted on two tiers under a bomb roof, with a terrace, capable of mounting 26 50-pound Columbiads; troops necessary, 1,014;

Bedloe's Island, mounting 24 guns, garrison, 312;

Ellis's Island, an enclosed circular battery of masonry, mounting 14 heavy guns, with barracks of stone and wood for one company of men and officers, 182 men;

On the Long Island shore of the Narrows a blockhouse was erected on the site of the present Fort Hamilton, by the first inhabitants who settled, in 1654. The work was as much of a protection against pirates and buccaneers as invaders. The English authorities for years discussed the feasibility of building a strong and permanent work at this point, but nothing ever came of it. During the War of 1812, the Americans constructed a small earthwork which they called Fort Lewis. A large fort that was to be built of granite blocks, was started at Sandy Hook, but never was finished. Work on the present Fort Hamilton on the Long Island side of the Narrows, was not begun in earnest until after the close of the second war with Great Britain.

Two interesting historical incidents are connected with this spot. The ship that brought over Colonel Richard Nicolls in 1664 dropped anchor a few yards distant from where Fort Hamilton now stands; whence the first communication to Pieter Stuyesant was dispatched, demanding the surrender of New Netherland.

One hundred and twelve year later the British Army of Invasion, under Lord Howe, landed on the site of the present Fort Hamilton.

While the General Government was consuming time in desultory discussion on the subject of fortifications, it was left to the State* as a matter of self preservation, to erect works of defense. New York City in 1806, bought 400 feet of ground under water off the battery on which Castle Clinton was erected (its name was changed in 1825 to Castle Garden). Provision was also made for the battery off Hubert street, and for the construction of Fort Gansevoort near the foot of the present West Thirteenth street.

During the winter of 1808 and 1809, 250 persons were given steady employment on the fortifications on the Staten Island side of the Narrows, the Legislature of New York having appropriated $100,000 for the purpose. Three works were under construction, the principal of which was Fort Tompkins. A year later report was made to the Governor that the effective water battery called Fort Richmond, at the Narrows,† was completed and ready for twenty-seven cannon. Two other batteries were then in process of construction, one to the east and the other to the south of this work. By the end of the year 1809, the smaller batteries were ready for platforms and guns.

As soon as war was declared, the general government made a requisition on the States of New York and New Jersey for 20,000 militia, to be concentrated in and around the city. The funds for the maintenance of these troops, however, were raised by the city of New York under promise of reimbursement on the part of the National Government. A committee of defense was promply appointed, and citizens were called upon to volunteer their services to work in the fortifications, with the result that from five

* From the "Return of all and singular the warlike stores and property belonging to the State of New York in the Commissary of Military Stores Department," January 20, 1812, the following facts are obtained:

The State had Arsenals at the following places: New York, Albany, Plattsburg and Elizabethtown, Russell, Watertown, Rome, Onondaga, Canandaigua and Batavia. It had deposited at Fort Richmond at the Narrows, 24 32-pounders and 33 24-pounders mounted; 2 12-pound brass guns.

The State possessed 10,823 stands of arms, 8,000 flints; had deposited 48 light brass 6-pounders among the thirty-two artillery organizations, and 42 light artillery brass 3-pounders

The militia of the State, according to the "Annual inspection return for the year one thousand eight hundred and eleven" submitted on January 25, 1812, was divided into eight divisions, and aggregated 95,326 of all arms; of whom 3,385 were cavalry, 2,619 artillery, 89,322 infantry. The general return is the same as those submitted to the Legislature in 1809 and 1810.

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† The following Words are as applicable to-day as when written in 1859, by that superb engineer officer, then Major John G. Barnard, subsequently general and chief of engineers of the United States Army, in a report which he made on "Fortifications." In view of the tremendous strides in inventing and manufacturing modern ordnance the sagacity of Gen. Barnard's utterances will strike the most indifferent laymen:

"The mere defense of the city against ordinary fleets," he wrote, "is no longer the question; but *through the defensive works to be here erected* (at the Narrows), *the nation is to measure its strength against the most lavish use of the resources of a great maritime power, aided by all that modern science and mechanical ingenuity in creating or inventing means of attack can bring against them;* in short, in fortifying New York, *we are really preparing the battlefield on which the issue of future momentous contests is to be decided.*"

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hundred to a thousand men, without distinction of class, were thus occupied daily.

Unprepared as the country itself was for war, the defenselessness of New York at the time was a matter of notoriety, not only to the inhabitants themselves, but to the enemy. It was in vain that the common council asked the Legislature to appropriate $250,000 for defensive purposes. An appel to Congress met with a similar fate. It seems ridiculous at this day to learn that the amount actually expended during the year 1812 for the defense of the metropolis, was only $11,500, and for the northern and western frontiers, $29,050. In 1813, the Comptroller's report shows that the following items had been expended: For the defense of the frontier, $15,000; purchase of arms, $37,500; expense attendant upon calling out of the militia, $12,500; and for transporting arms, $2,702.

At the same time an appropriation of $22,000 was made for a redoubt or protecting work on Signal Hill near the Narrows, Staten Island. In 1814, when the Republican party returned to power, the generosity of the State was more conspicuous; $98,500 were voted for defense and $50,000 for the sufferers on the Niagara frontier. January, 1815, it was shown that $25.500 had been contributed for defense, $205,000 for the support of families of persons who were called into the service, $50,000 for the pay of the militia and $15,000 for the sea fensibles and armorers.

In March, 1814, the city of New York was compelled to barrow $100,000 to be used in defense of the city, which equipped, manned and maintained at its own expense a large body of troops who were placed in the works. September 23, 1814, the defenses around New York were described as follows: "A strong blockhouse mounting a 24-pounder, stood at the west end of Rockaway Beach for the purpose of repelling boarding parties in small boats. A tower of solid masonry had been designed by General Joseph Swift at Hell Gate on Hallet's Point. It was called Fort Stevens. For this the government had made a partial appropriation. A small battery stood at Mill Rock at Hell Gate." The works at the Narrows were far from complete. Colonel Jonathan Williams, engineer in charge, had changed the orginal plans. He estimated that 500 men could stand out against 5,000 and that the works were capable of giving shelter and accommodation to 1,500 troops. Fort Hudson was then completed, Fort Richmond nearly so, and another battery was contemplated in the rear of both.

A line of military defenses was stretched across the island

from the barrier gate at McGowan's Pass which commanded the Harlem river to the barrier gate at Manhattanville Pass which commanded the Hudson river:

"Fortifications on Benson's Point near Third avenue and One Hundred and Sixth street.

"Fort Clinton, between One Hundred and Sixth and One Hundred and Seventh streets and about one hundred and seventy yards east of Sixth avenue.

"Fort Fish, between One Hundred and Fifth and One Hundred and Sixth streets and about ten yards east of Sixth avenue.

"A stone tower about fourteen yards south of One Hundred and Ninth street and seven yards west of Seventh avenue.

"A stone tower between One Hundred and Thirteenth and One Hundred and Fourteenth streets, and between Ninth and Tenth avenues.

"A stone tower on the south side of One Hundred and Twenty-first street and about one hundred and ten yards east of Tenth avenue.

"A stone tower on the south side of One Hundred and Twenty-third street and about fifty-four yards east of Tenth avenue.

"Fort Haight, at Manhattanville Pass, about twenty yards north of One Hundred and Twenty-fourth street and one hundred and twenty yards east of Eleventh avenue.

"Along, and in the neighborhood of King's Bridge road, a number of redoubts and forts built during the Revolutionary war were still standing in 1814, between Bussing Point road—One Hundred and Forty-third and One Hundred and Forty-fourth streets, Seventh and Eighth avenues—and King's Bridge. These fortifications consisted of solid earth embankments from six to eight feet in height and were in the majority of instances exceedingly well preserved. The most conspicuous were situated as follows:

"One hundred and Forty-fifth street, One Hundred and Sixty-first street; at One Hundred and Seventy-fifth to One Hundred and Seventy-sixth the road passed sixty-seven yards east of Twelfth avenue and 900 yards east of a fort and redoubts on a point of rocks on Hudson river, thirty yards south of One Hundred and Seventy-sixth street and 200 yards west of Fourteenth avenue. At One Hundred and Eighty-third street the road ran 343 yards east of Fort Washington on Thirteenth avenue; at One Hundred and Ninety-second street 533 yards west of Fort George; at One Hundred and Ninety-sixth street 233 yards east of Fort

Tryon; at Two Hundred and Twenty-sixth street 150 yards east of Fort Prince Charles, on Tenth avenue, on the southerly side of that street."

From 1808 to 1816 the State of New York appropriated $272,000 for the fortifications on Staten Island and the defense of the port of New York.

The report of the Secretary of War, in 1818, shows that "the only work now progressing in New York is Fort Lafayette, at the Narrows upon Hendricks Reef; will mount 96 cannon, and cost $275,000; is more than half finished and can be completed in the year 1819, and will require $110,000 to be appropriated. The other positions which must by necessity be occupied to complete the defenses of New York, are: First, Sandy Hook; Second, Staten Island; Third, west end of Long Island; Fourth, Brooklyn Heights; Fifth, Frog Pond near the Sound."

AN APPARATUS FOR POINTING BY MEANS OF AN ELEVATED LINE OF METAL,* AUTOMATICALLY FINDING CONCEALED POSITION.

Presented to the Brussels International Exposition by Captain Froissart, of the Fifteenth Artillery Regiment of France.

The apparatus that I have invented renders masked fire more practicable, and thus faciltates for field artillery a development that by many people of judgment is considered necessary.

Without entering into the minute details of a precise description, such as I prepared for the inspecting committee, I wish in this outline to give an idea of my apparatus, pointing out the object I have sought and the results that I think I have obtained.

I. THE PROPOSITION.

Upon the battle fields of the future the conditions that should govern the employment of artillery will, by reason of the introduction of smokeless powder, be quite different from the conditions that have in the past controlled.

General Langlois, who a few years ago lectured at the staff school in Paris, was one of the most distinguished generals from the artillery arm, and he wrote: "It is becoming imperative that the artillery, as well as the other arms, should make use of the cover offered by the nature of the ground.

"Unfortunate would be the batteries which, in approaches and in action, could not find cover! Uufortunate would be the troops supported by such batteries!

"There must now be made in the artillery the development that was, between 1859 and 1866, made in the German infantry. Neglecting the use of cover through a spirit of false chivalry, would be a repetition of the error of the Austrian infantry before 1866, and it would lead to the same results; the artillery would be quickly paralyzed, and would become not only useless, but even baleful—it would be a millstone about the neck!"

Further, speaking of the height suitable for the observation ladder from which, in his opinion, every battery commander should direct, General Langlois writes:

* "Line of metal" is here used as meaning the line passing through the front and the rear sights.—Tr.

"This height ought to be at least such as to prevent the enemy's seeing the flash from a gun firing smokeless powder."

And finally: "Tactical requirements demand that the artillery habitually use masked fire; the artillery must prepare for obedience to the requirements of tactics; *it can.*"

In the French Regulations of 1895, in paragraph 319, which refers to the maneuvers of batteries with horses hitched, there is on this subject the following:

"If, in view of the circumstances of battle, of the opportunities offered by the nature of the ground, and of the time that he has, the captain judge proper, he may: Halt the pieces behind a ridge that protects them from the sight of the enemy; make the drivers dismount; afterwards have the pieces brought as near as possible to the crest, all the while remaining under cover; then have the pieces moved by hand to their fighting positions. Thus will he be able to open fire before his presence has been discovered by the enemy."

Since the line of metal of a field piece in action passes through the front sight, that is to say at a maximum height of 4′ 3″ above the ground, and since the distance from the ground to the top of the heads of a great number of horses exceeds 6′ 7″, there is a minimum difference in level of 2′ 4″ to be passed over by movement by hand, for surface slopes of $\frac{1}{10}$, $\frac{1}{20}$, $\frac{1}{30}$ and $\frac{1}{40}$ this difference in level would require the pieces to be moved by hand over distances of 23′, 46′, 69′ and 92′ respectively. In the vicinity of plains, surface slopes of $\frac{1}{10}$ are rare; slopes ranging from $\frac{1}{20}$ to $\frac{1}{30}$ are usual.

Now the autumn maneuvers have demonstrated to officers who have made practical tests, that in any other than a soil as well settled as the soils of the practice grounds and of the Châlons camp, movement by hand for a distance of only 23′ is very difficult and requires considerable time.

Moreover, it is a just observation that, after all the trouble indicated in the paragraph quoted, the artillery attains, not masked fire, but half masked fire. For in order to succeed at all in moving the pieces by hand over the great distances indicated, all the cannoneers of a number of pieces should be employed to move each piece in that number. Now, in moving the first pieces to their firing positions, the heads of the cannoneers, then the upper part of their bodies, then the tops of the wheels, and finally the chases of the pieces themselves, appear above the crest. From this it results that the observant enemy has a number of targets long before the last pieces are established upon

the line, and it will be some time after this establishment before the already exhausted men, sighting by means of the usual line of metal, will be able to reply to the enemy's fire.

Paragraph 319 of the Regulations is interesting then only on account of the tendencies that it manifests; for if, as the regulations prescribe, the captain, before ordering the movement, take into consideration the nature of the ground, he must ordinarily reject this maneuver.

It is true that by using indirect fire, the captain could mask his battery; and in various parts of the French regulations there are for indirect fire rules that often give good results, when applied by instructed gunners firing at broad targets. But would it not be rash to assert that good results could be often obtained by gunners of a war personnel firing at masked targets?

If, then, paragraph 319 of the French regulations shows that the French artillery wishes to make use of masked fire, it by no means shows that it can.

Is masked fire possible to the artillery of other countries? If so, how perfect are the methods? I claim no precise knowledge as to the development of the proposition in foreign armies. However, the "*Revue d'Artillerie*" for January, 1893, announced that Germany had provided her field guns with a pointing apparatus capable of measuring azimuth angles; this apparatus is in France known as a "Goniomètre."

It is obvious that, with this apparatus, batteries established behind a ridge, could, without great difficulty, be approximately trained upon the target.

The battery commander, however, must have the means either of laying one of the pieces by direct sight, or of measuring the angle at the battery position between two lines running, one through the target, which the battery commander sees, and the other through a land mark that all the gunners see.

Without knowing how satisfactory the battery commander's goniometer has been, I may state that it is not entirely satisfactory, if it does not fulfill the requirement mentioned by General Langlois; that is, if its use does not prevent the flash being seen.

Indirect fire has, as is shown later, numerous inconveniences. But if, having determined to use indirect fire, the artillery took advantage of being able to conceal, not only its personnel, but even the flashes from its guns, would not those inconveniences be greatly compensated for?

The goniometer must, then, be on a field observatory that

makes it practicable for the battery commander to be 15' above the ground, that being the height above the ground of the highest point of the flash. And on the other hand, having given the field observatory, equally essential is it that it be provided with a goniometer; for the process of pointing a piece by direct sight from the top of a ladder, involves that tedious method of approximation, since the ladder must eventually be erected in the prolongation of the line of sight. Moreover, pointing by direct sight a piece that one directs from a distance of several yards, is not closely approximate.

If the necessity for a goniometer on the observatory is granted, it is now in order to selected a goniometer. The simplest apparatus, because it requires no support other than the land, is evidently the sextant held horizontal; but this apparatus, being so easily thrown out of adjustment, cannot be expediently slung over the shoulder on the march. So we must adopt an apparatus that can be fixed in a groove at the top of the observatory; and this is not too complicated. But it is another matter to use the instrument on a ladder for the purpose of obtaining cover that will conceal the flashes. We must be able beforehand to select a point 15' below the crest of the covering ridge; if the ladder be erected below that point, the tangent cannot be seen; if the ladder be erected above that point, the observer will be seen. There is no way of determining beforehand whether a point is the proper distance below the crest; and one succeeds in finding the proper joint only by ceaselessly moving a raised ladder, and that is a procedure that seems out of place on the battle field. Finally then, I do not think that there has heretofore been invented an observatory capable of giving masked fire that prevents the flashes being seen.

Of course the battery commander could not set up a mounted goniometer at a point 50 or 100 yards in front of the battery; for, expect in the special case of a very distant land mark, an angle measured by means of a goniometer so placed would be of no practical use to pieces so far in rear.

Independently of this unsettled question of an observatory 15' high, let us consider indirect fire from a battery provided with goniometers and stationed at any given distance below the crest. In the first place, the battery will experience the inconveniences of indirect fire, owing to the centralization in the captain of the operations of pointing; and this centralization is necessary, for the captain alone sees the target and the points of fall, and hence he alone is able to determine the range and the direction, and to

observe the error. In the second place, since the target is masked, the battery commander will generally be obliged to waste a large number of shots in determining the range. Indeed, if the enemy be concealed, there will probably be visible for ranging purposes only one or two objects, upon which it will be necessary to concentrate the shots, in order to determine the direction of the error.

Now, the degree of convergence of pieces pointed by means of goniometers, depends upon the direction of the chosen land mark and upon unknown distances from the guns to the land mark and from the guns to the target. Hence one could not, upon the ground at least, determine beforehand the correction to be made in the azimuth of each piece, in order that the direction of the error might be observed. A land mark that is directly in prolongation of the line of pieces is the only one adapted to a rapid pointing of all the pieces.

We see, then, that indirect fire aided by the use of goniometers, is when first begun, still slow and ineffectual. This slowness would be an inconvenience of but little importance, were it not for the fact that the enemy is by the flashes warned of the battery's position. Seeing the flashes, the enemy is able to reply immediately; and it is probable that, by employing progressive fire or by ranging upon the sheltering ridge, he will be able to reply effectually.

From the preceding considerations it follows that the German method of indirect masked fire by the use of the goniometer, as well as the French method of half masked fire indicated in paragraph 319 Regulations, if not a poor solution, is at best an incomplete solution of the problem proposed. This, however, should not prevent our considering the goniometer a valuable instrument for laying on a target.

In view of the difficulties indicated there are many officers desirous of advancing boldly and firing furiously, while, as in the past, crying "*Sursum Corda*!"* We doubt the probabiliy of this opinion's successfully standing the test of a day of battle. "*Sursum Corda*" should be the soldier's motto, for it is war's great resource; it should not, however, forestall precaution nor obscure tactics. If, as General Langlois has assented, "the artillery must and can use masked fire," it would be calamitous indeed, should the artillery in future not be prepared to use it as a standard fire.

* Referenc to: "Lift up your hearts"—"We lift them up." Tr.

While General Langlois was making to the technicists an appeal for methods to facilitate masked fire, I was engaged in the July field exercises of the Douai garrison. In performing my humble duties as battery commander, I was led to observe that, whenever we took the guns from the road in order to go into action in standing corn, the lines of sight for our guns were intercepted. Moreover, in the fall maneuvers I found that the movement by hand called for in our regulations could be executed only with great difficulty; the movement by hand required in rectifying the alignment after unlimbering, appeared to be the greatest that could expediently be demanded of the cannoneers.

It was difficult for me to accept the idea that the artillery had to resign itself to the impossibility of being at the same time really covered and able to point by means of a tangent sight. For in thus resigning itself, the artillery would either renounce direct fire, which I consider the only practicable fire, and accept the complications of indirect fire; or it would renounce masked fire and go with its teams to occupy the crest, horses and riders standing out against the horizon. In either case the artillery would run the risk of being decimated before it had regulated its own fire.

Accordingly, I was led to seek for the artillery the greatest protection compatible with direct fire, and I was led to seek also the means of evading the principal inconveniences of indirect fire.

For half masked fire with difficult movement by hand, it has to me appeared possible to substitute completely masked direct fire without movement by hand.

For indirect fire with so low an observatory that the flashes betray the battery, I have thought there could be advantageously substituted indirect fire with an observatory on wheels, sufficiently high to raise the eye 15′ from the ground, thus concealing the flashes.

I set to work with all the ardor that is given by a desire to perform useful work; and after a series of attempts, failures, and new beginnings, I have succeeded in devising apparatus that experiments made by me and by others better qualified, permit me to believe practicable. However, in spite of these results and in spite of the encouragement they have obtained from the Minister of War, I have not realized my hope of seeing my name attached to a reform of the pointing methods of the French artillery. Yet, there remains for me the satisfaction of telling what I have done for my branch of the service, and the satisfac-

tion of giving an indication of its progress by exhibiting at Brussels, with authority from the Minister of War, the apparatus that I have invented.

II. THE APPARATUS.

So far I have spoken of how I was led to endeavor to improve the method of executing masked fire. I am now going to describe briefly the apparatus that I have devised, and to point out the uses that can be made of them.

The line of metal of a field piece in action is generally not more than 3′ 9″ or 4′ 3″ from the ground. In order that a piece may be aimed upon the very spot on which it is unlimbered behind a mask that prevents the drivers being seen, the line of metal must be as high as the eye of a man on horse back, *i. e.*, about 7′ 3″ from the ground.

If the battery occupies a position 7′ 3″ below the crest, it will be able to pass through the critical period of going into action without being disturbed, at least by that battery from which it is masked; here is already one real advantage. But as soon as the battery fires, it runs the risk of being discovered, for the highest point of the flash is 14′ or 15′ above the ground. If the enemy is observant, he will be able to reply soon by employing progressive fire in the direction in which he has seen the flashes. Therefore are we led to use a greater mask, if we can; but the farther below the crest the battery takes its position, the worse are the conditions for defending the approaches, and for certain slopes, the battery by taking a position far below the crest would run the risk of firing into the ridge. Hence, the battery should be established either upon the very line that gives a mask for the drivers mounted, or upon the very line that gives a mask for the flashes; it should not be established between these lines.

By such considerations I was convinced that a pointing apparatus suitable for masked fire, must be "An Apparatus for Pointing by Means of an Elevated Line of Metal, Automatically Finding Concealed Position."* That is to say, the apparatus must enable us:

1. To determine automatically upon the ground, a line that is a given distance below the crest of a covering ridge.

2. To train upon the target, by using an auxiliary line of metal, the pieces that are established upon the line determined.

This pointing apparatus may be constructed in one of two

* In the French of the inventor the name of the apparatus is: "Appareil de pointage à ligne de mire surélevée, autobathymétrique."—Tr.

ways, accordingly as we either content ourselves with masking the drivers mounted, or resolve to conceal from the enemy the flashes of the pieces. For masking mounted drivers a line 7′ 3″ below the crest is sufficient; for concealing the flashes, the line determined must be about 15′ below the crest.

For masking mounted drivers the apparatus consists of a jointed parallelogram, carrying a peep sight and a front sight; it is thus fitted for direct fire. No field observarory is necessary; the

Fig. 1.

battery commander on horse back and the gunner standing upon the gun carriage, having their eyes about 7′ 3″ above the ground, can see the target, can readily determine the line to be occupied by the pieces, and can observe and point. (Fig. 1.). While performing these duties the captain and the gunner, as well as the members of the battery that bring the pieces into firing position, are masked from the enemy. Care must be taken by all not to pass the line indicated by the battery commander.

The jointed parallelogram may be made of U shaped standards (Fig. 2) the sides of which rapidly approach as they rise; these standards are firmly fastened by means of hinged brackets, to the side of the piece opposite the side on which are the ordinary front sight and rear sight. These standards, being separated by the simple rotation of a ring, are capable of folding upon the piece.

Instead of folding standards, movable bamboo standards may

Fig. 2.

be used in the parallelogram; or, if it be desired, the gunners may be provided with sabres suitable for use as standards. In either of these cases, the standards are at the time of use inserted in oscillating sockets that are fastened to the piece by means of hinged brackets like those used with folding standards.

Whether folding or detachable, the standards support a Broca front sight and an ordinary tangent sight, and thus afford an auxiliary line of metal. The length of this auxiliary line of metal is the same as that of the ordinary line of metal. Some springs seated in the hinged brackets keep the standards perpendicular to the axis of the piece and to the axis of the trunnions; these springs serve also to take up the shock of firing and the jolts of travelling.

For masking the flashes the apparatus, called a "Battery Lookout,"* consists of an observatory mounted upon wheels and provided with a goniometer; it is particularly suitable for indirect fire, at least so long as our present gun carriages are in use.

A kind of basket resembling a balloon car and made of pliant metallic rope, is supported by two beams ten feet long; these beams may be fastened by rotating joints to the axle of any artillery carriage. This basket car supports an observer, who,

* "Vigie de batterie."

either at a halt or on the march, can have himself with his sighting apparatus, raised to such height as he pleases between 7′ and 15′. At command from the observer, a cannoneer seated upon the limber of the carriage that carries the observatory, raises or lowers the car by means of tackling, the fall of which winds about a windlass provided with pawl and ratchet; this windlass is fastened upon the futchel of the limber, and is within easy reach of the cannoneer.

The observer's eye is about 7′ 6″ from the ground when the supports are completely raised.

At Brussels the apparatus is exhibited mounted upon an ammunition wagon; it can be, however, mounted upon a gun carriage. For I have succeeded in demonstrating that, using an

Fig. 3.

elastic spring fastening, it is possible for this observatory, while raised and holding an observer, to endure the shock of recoil without the observer's being disturbed. (Fig. 3). With non-recoil carriages, such as those of the Bange and Piffard system

for field service (described in the "*Revue d'Artillerie*" for June, 1897), there can be no doubt of the possibility of mounting the "Battery look-out" upon the gun carriage.

The observatory supports are at present nothing but spare shafts inserted in boxes that are made on the discs of the axle shoulders. If the observatory were mounted upon a non-recoil gun carriage such support could be made of three parts so joined as to fold upon one another; in this way, when masked fire gave place to open fire, the basket car could be put under the front of the carriage like an opera hat under a chair.

The method of using the "Battery Look-out" is as follows:

When the battery is sheltered by a ridge, and when the captain wishes to fire from a position that is a determined vertical distance below the crest, the observer is raised a height equal to the determined distance, and the observatory advances toward the crest; when the observer sees the target, the observatory stands on one point of the desired firing line. One point found, the observer has simply so to direct the carriage as continually to see the target over the crest; doing this, he remains constantly on the contour that is, the required distance below the crest.

If we think of the groping necessary in using ladders, of their instability, and of the ease with which the observers are thrown from them by the least distraction, one must admit that the "Battery Look-out" presents the advantages of uninterrupted observation, and of safety for the observer; these advantages are beyond value.

The "Battery Look-out' is, on the whole, the instrument of a new branch of geodesy—the measurement of differences of level. The object of these measurements is to trace directly upon the ground contours, or lines having all points of each the same vertical distance below a crest, however irregular that crest may be.

This observatory erected behind a gun makes it possible, as General Langlois proposed, to point that gun by sight with the relative precision which that kind of pointing allows.

Not only is the observatory movable, but also can the observer move about in it; hence the observer using the "Battery Look-out" is able to place himself in the prolongation of the desired line of sight much more readily than he could from the top of a ladder. But in order not to have to move the "Battery Look-out" to a position directly in rear of each piece, both the observatory and each piece should be provided with goniometers. The observer could then measure the azimuth angle between the

target and a land mark that is seen by all the gunners; and the gunners could train their pieces upon the target by using the azimuth angle gived them.

The observatory car is provided with a crude goniometer; a graduated limb that turns freely in the upper basket-hoop supports a standard about 2′ high, and this standard carries a sight. If, using this apparatus, the observer sights successively upon the tangent and upon the land mark, he determines the angle that the gunners of the pieces are to use in sighting upon the land mark in order to train upon the target; each piece is, of course, provided with a goniometer of some kind.

The limb of the observatory goniometer carries a traveller, which should at the time of the first sighting be set at the zero of the limb; thus no computation is necessary, the angle between the target and the land mark being read directly.

The dimensions of the observatory goniometer are such that an arc of about 0.04 inch measures an angle of 10′, and this angle corresponds, on a range of 2625 yards to an error of about 9 yards, or about half the interval between pieces.

For the pieces a goniometer of any model whatever range be used. I have made two kinds of goniometers for use with the guns, and I exhibit both. One of them was described in the "*Revue d'Artillerie*" for September, 1896, under the title "Appareil de pointage elliptique." That name was given because the essential feature of the apparatus is a sight that slides along a graduated ribbon that forms the two radius vectors of an ellipse. The foci of this ellipse serve as axes of rotation for two Broca sights particularly adapted for the purpose; these sights turn about the foci under the action of the two branches of the ribbon.

The second is nothing but a quadrant to which is fitted a detachable sight with graduated bar, the very accurate graduation of which may be used for measuring both horizontal and vertical angles. This instrument held horizontal is applied to the face of the piece;* some studs on the frame center the quadrant and hold it steady during the marking.

With either of those apparatus angles are measured rapidly and acurately. Though we do not avoid the slowness incident to being unable to cause the piece to converge beforehand on a chosen ranging point; yet, at least, are we able to proceed calmly, since the enemy cannot see even the flashes of the guns that are throwing projectiles upon him.

* The quadrant held horizontal could also be supported by a circular rim of about 3″.6 (90 mm.) diameter; this rim being held perpendicular to the axis of the piece by means of a shank that fits in one of the oscillating sockets already mentioned.

It is scarcely necessary to observe that for too short ranges, or over ground of too steep a slope, firing from a position 15′ below the crest would subject us to the possibility of firing into the ridge.

The maximum slopes that allow the projectiles to pass, are $\frac{1}{12}$, $\frac{1}{10}$, $\frac{1}{7}$, respectively, for ranges of 2187 yards, 2734 pards, and 3281 yards, the slope being counted from the lowest point of the wheel to the covering point of the ridge.

The limits calculated for the trajectory of the 90^{mm} (3″.6) piece indicate that with this piece it will generally be possible to fire behind cover that conceals the flashes.

Even though only occasionally possible, a method of fire that gives the enemy no indication of the position of the battery that is firing upon him, is so tempting that one is led to try, at least, to provide the artillery with instruments that make that method practicable.

Wholly masked fire has, then, its limits; but practicable always for ordinary artillery ranges, whatever be the slope of the ground, is direct fire with the "Jointed Parallelogram."

III. USE OF THE APPARATUS IN OPEN FIELD FIRE.

Either the "Battery Look-out" or the "Jointed Parallelogram" is capable of rendering in open field fire services which, in the eyes of many officers not very favorable to masked fire, excel the services that either apparatus renders in masked fire.

The "Battery Look-out," either on the march or erected on the battle field with a tree or a house for background, enables the battery commander to extend his field of view, to survey the approaches, and to examine the nature of the ground.

The "Jointed Parallelogram" is particularly valuable for pointing, when the gunner of a piece in action finds that a bush or some high grass hides the target; for it is not possible to determine before unlimbering whether the target will be hid from the gunner, since the target is not made known to the chiet of section before unlimbering.

"Around Hay no matter what position the Foncin battery chose, it always had before it vines, shrubs, or hedges; and any one of those were sufficient in that flat country to conceal from the gunners the walls of the gardens and of the houses."* The result was that the infantry paid with its blood for the lack of equipment of the artillery.

"What is the use," asks General Langlois, "of the artillery's

* General Ducrot: "La Défense de Paris."

being so powerful, if the smallest obstruction in its front is going to destroy that power? If, before the crops are harvested, one visits the battle fields of 1870-1871, one will be convinced of this truth, viz.: If the gunner must see to point, the artillery will generally be useless."

That truth would perhaps be evident to all artillery officers of our service, if the grand maneurers were, not Fall maneuvers about Châlons camp, but July maneuvers in ordinary fields. While proclaiming that truth, General Langlois did not think that an ardent advocate of direct fire, for which in France there is great preference, would one day give gunners the material for sighting by means of a line of metal one yard higher than the ordinary line of metal.

There are those who think direct fire by means of the tangent sight preëminently the most practical fire, because it does not make each piece a passive part of a complex machine called a battery, but leaves each piece its individuality, thereby enabling it to render a good account of itself even when the battery is disorganized. Those who so think will be glad to learn that it is possible, without resorting to the apparatus of indirect fire, to relieve gunners of the difficulty against which they had to struggle when using the natural line of metal. The usefulness of the apparatus of indirect fire does not admit discussion ; but do not such apparatus run the risk of being rendered temporarily useless when the ordinary line of metal is useless?

Though the artillery may not take such a position as to mask its flashes, and though it may not think of employing indirect fire, yet, obliged to go into action whenever it finds free ground, the artillery may use the Parallelogram for sighting over any vegetation that chances to be in its front. Thus, far from destroying the power of the artillery, chance obstructions become masks to protect it partially, at least, from the sight of the enemy.

Finally, while everywhere people seem to be considering as the most urgent need more rapid artillery fire, it has occurred to me that someone might set to work :

1. To increase the security of the personnel by giving the batteries the means of firing, and, if desired, of even changing their position behind a curtain which is always hung.

2. To increase, at the same time, the efficiency of the fire, for that varies directly with the composure of the personnel ; moreover the efficiency of the fire will be increased by its being possible to employ direct fire.

3. To reduce the fatigue of the personnel suppressing move-

ments by hand, which have heretofore been necessary for direct fire that was only half masked.

4. To render it difficult, by taking his target from him, for the enemy to determine the range, thus obliging him to waste in progressive fire a quantity of ammunition that may be out of all proportion to the results obtained. As a result we exhaust the enemy's ammunition as soon as possible, and that is, perhaps, the highest principle of modern tactics; from time to time are machines invented for firing more rapidly, but the means of carrying the ammunition to feed those machines are not yet found.

Each of the methods of masked fire gives some one of the advantages enumerated above; masked fire using the "Jointed Parallelogram" gives them all by allowing us "to see without being seen." The Jointed Parallelogram offers, besides, advantages that are, and that will remain, peculiar to it:

1. Greater facility in following a movable target or in changing objective.

2. Fewer lost shots and consequently greater rapidity in determining the range, for direct pointing enables us to make sure of the initial convergence of the pieces upon one ranging point.

3. Possibility of going into battery and of firing anywhere in spite of vegetation, and of using cover even in the second and third positions of the artillery.

The cavalryman remains hidden behind the ridge, and the infantryman can sight without letting anything but his cap project above the cover; is it not necessary that the battery commander and the gunner should be able to see without being seen, and to make without interference the sighting necessary for firing? This should be possible to the gunner mounted upon the gun carriage and to the captain while with his battery, to which before all else he should give his attention. I think that my apparatus gives the artillery this possibility, to which in its turn it can aspire.

My apparatus are somewhat opposed to conventionalism. My claim of fixing upon a piece in action a parallelogram, in such a way as to render it almost insensible to shock, has appeared rash to more than one of my fellow officers; however, prolonged experiments have demonstrated that it was not an empty claim, and that the resistance to shock is absolute.

On the other hand, I believe I have have proved that my "Battery Look-out" fixed upon an ammunition wagon is easily man-

aged; and also that it has all the desired stability, since, mounted on a gun carriage and holding an observer, it has proved able to withstand the shock of discharge. I declare also that the artillery will frequently have to abandon the advantages of masked fire, and procure before all the extended fields of view.

"Masked fire," wrote General Langlois, "is adopted, not with a view to constantly seeking cover, but in order to render the artillery capable of fighting anywhere and against any objective visible to the captain."

I do not disguise the fact that my apparatus have the fault of being additional mechanism to be added to a material already too heavy and too complex. This objection, however, has been made to all the inventions that have, from time to time, been made in the modern artillery material; this objection was made to the method of loading at the breech, but nevertheless breech-loading prevailed.

It is unnecessary to point out how many operations of masked fire either condemn the artillery to showing itself, even though it submit to the intolerable movement by hand, when it wishes to employ direct fire; or condemn it to revealing its presence by the flashes, when it resigns itself to the complications of indirect fire. These inconveniences must disappear, and I have shown that they do disappear when the line of metal is raised in one case to the height of the eye of a man on horseback (7'); or in the other case to a height a little greater than that of the the highest point of the flash (15').

I have described a "Jointed Parellelogram" that gives the artillery the means of pointing anywhere (through the narrowest opening through which a man can see the target) and that allows the batteries to employ direct fire while masked by a ridge.

I have described a "Battery Lookout" that makes the battery commander a giant at will, giving him a height of 15'; he is able to have this height not only at a halt, but also on the march; thus is the captain able to watch the approaches, and to see beyond the vanishing zone of the flashes of the battery that is masked at his feet. As a consequence the gunners obtain all the information necessary to them for effectively employing indirect fire.

The proposed measures for giving to the artillery all those great advantages, leave the artillery materiel as it is; it is sufficient to add to it a few instruments of relatively insignificant weight and volume, and of absolute simplicity.

I don't know how near is the time when our branch of the

service, interrupting its hypnotic contempletion of "Rapid Fire," will recognize that a change is necessary in the method of pointing; but this I know: Whenever comes the time in which field artillery will wish to make habitual use of masked fire—in the prophetic words of General Langlois—"it can."

[Translated by J. M. Williams, First Lieutenant, First Artillery.]

PROFESSIONAL NOTES.

ARMOR AND PROJECTILES.

A New Method of Manufacturing Armor Plates.

The *Revue Industrielle* of February 12, 1898, presents a description of a new method of manufacture of armor plates, which we briefly describe in the following: The method is used by La Société Anonyme des Hauts fourmeaux, Forges et Aciéries de Denain et Auzin in France, and is the invention of Jean Werth, the technical manager of the works.

The aim of the inventor is to produce a steel plate of homogenous and uniform chemical composition throughout, but which, however, will have one hard surface with a high resistance to impact, while the opposite surface is kept malleable and relatively soft. In order to obtain such results Mr. Werth takes advantage of the property possessed by certain metals, suck as nickel, cobalt or manganese, or alloys oj nickel or cobalt with manganese, to impart to the steel into the composition of which it enters hardness when heated to a temperature between cherry red and bright cherry red and cooled afterward, or malleability when heated to a temperature from dull to nascent red. These phenomena are due to the direct action which these elements have on the carbon, the iron and the other chemical components of the metal. This action is of such a nature that without occasioning any change in the chemical composition of the metal it produces an allotropic transformation of its constituents. The metal becomes hard after having been heated to a cherry or bright cherry red and cooled slowly in the air, or it becomes malleable after having been heated to a dull or nascent red and cooled in the air.

The steel used is open hearth steel, free from sulphur and phosphorus. It contains from 5 to 15% of nickel or cobalt, or from 2 to 12% of manganese. By varying the relative percentage of these metals many grades of steel can be obtained, which all can easily be worked under ordinary conditions of heat. Silicon, chromium and tungsten may be present within their normal limits without in any way rendering the steel unfit for its special purpose.

The plates are made from the steel by hammering or rolling. They can be worked, drilled and in general submitted to any operation required in the manufacture of armor plates. When finished they are left to cool in the open air without danger and without any special precautions. After this they are submitted to the special process required to harden them on one side and to keep them malleable on the other side. This is done in the following manner:

The plate is placed in a cold heating furnace, and slowly and uniformly heated to a temperature either dark red or nascent red, according to requirements. Any annealing furnace where the temperature can be regulated can be used for this purpose. The dark red heat is used on plates containing the least percentage of the above quoted metallic elements, while plates with the highest percentage of the same elements are heated to a nascent red. As soon as the right temperature is obtained the plates are removed from the furnace and left to cool slowly in the open air. They are now homogeneous

throughout and malleable, and can be submitted to any work to which ordinary steel with a tensile strength of from 85,000 to 110,000 pounds per square inch can be submitted.

A series of tests gave elastic limit of the metal, 70,000 to 110,000 pounds per square inch; tensile strength, 110,000 to 140,000 pounds. Bending a 4 x 1¼ inch plate around a diameter equal to twice its thickness without rupture. The metal is not brittle and can easily be bent.

After the plate is given its final shape it is ready to be submitted to the operation that impart hardness to its impact surface. On this side the plate can be hardened to any desired depth by heating it to that depth to a temperature between cherry red and bright cherry red. This heating is done slowly and uniformly, and good care is taken to keep the temperature of the rear surface at about nascent red, corresponding to 800° to 900° F. For this purpose this surface is kept cool by a circulation of water or air while the impact surface is heated. The temperature on both surfaces can be checked at any moment by the use of pyrometers, or by means of thin plates of either lead, zinc, tin, etc., whose melting points are well known, or by any other suitable means or device.

The heating of the impact side is done by building up a heating furnace in which the plates themselves constitute the walls and the bottom with their impact surface turned inward. They are exposed to the heat of the furnace. while their malleable surfaces are cooled on the outside bp means of air or water. It is most important that the heat in the furnace should not only be uniform throughout the furnace, but should be kept uniform during the whole heating operation, so that the plates will gradually be brought to a bright cherry red to any desired depth. In order to allow the heat to gradually penetrate the plate to the desired depth, the heating must be moderated from time to time during short intervals. Gas furnaces, being more easily controlled, give better results than furnaces directly heated with coal.

Instead of heating the impact surface in furnaces as here described very good results are rapidly obtained by plunging these sides of the plates into a bath of molten metal, such as lead. heated to a cherry red. This metallic bath is previously heated to the desired temperature, and after having skimmed the surface of the molten metal from all impurities the impact surface is immersed to the desired depth. During the whole operation the temperature of the metallic bath must be kept uniform, which is checked by means of a pyrometer. The malleable surface in this case also is kept below dark red in the same manner as before described. After the impact surface has been heated uniformily to a cherry red and to the desired depth the plate is removed from the metallic bath and the impact surface is left to cool gradually in the open air while the malleable side is prevented from rising above dark red. The moment the temperature of the impact surface has fallen to between dark and nascent red the more active cooling of the malleable side is stopped and the plate, raised from the ground, is left to cool slowly and uniformly. This finishes the plate as far as metallurgical operations are concerned.

Should a plate become warped during the hardening period it can be straightened again under the hammer when the temperature throughout has become uniform at a dark red heat. A curved plate is given its shape after it has been made malleable, then it is again heated up to a dark red and left to cool in the air. Then only the hardening of the impact surface is resorted

to. In the case of a curved or irregularly formed shape this hardening cannot be done in a metallic bath, but must be done by exposing the impact surface to the contact of the flame.

It is difficult to obtain from such a plate test pieces, because it is impossible to do any shop work on the hardened side.

With great difficulty it was possible to obtain such test pieces from the softer varieties of steel. In such cases the tensile strength was found to vary between 140,000 and 190,000 pounds per square inch. The metal had great resistance to shock, and yet it could be bent to an angle above 90°.

In the harder plates the impact surface resisted every attempt to work it, while the rear surface had remained perfectly malleable and could be easily submitted to any ordinary shop work.

—*The Iron Age*, March 3, 1898.

MILITARY GEOGRAPHY.

Ocean Cables in War Times.

By ALEXANDER PORTER MORSE.

Eleven submarine cables traverse the Atlantic between 60° and 40° north latitude. Eleven of these connect the Canadian provinces and the United States with the territory of Great Britian: two (one American, the other Anglo-American) connect France. Of these seven are largely owned, operated or controlled by American capital, while all the others are under English control and management. There is but one direct submarine cable connecting the territory of the United States with the continent of Europe, and that is the cable owned and operated by the Compagnie Français Cables Telegraphiques, whose termini are Brest, France, and Cape Cod, on the coast of Massachusetts. All these cables between 60° and 40° north latitude, which unite the United States with Europe, except the French cable, are under American or English control, and have their termini in the territory of Great Britian or the United States. In the event of war between these countries, unless restrained by conventional act, all these cables might be cut or subjected to exclusive censorship on the part of each of the belligerent states. Across the South Atlantic there are three cables, one American and two English, whose termini are Pernambuco, Brazil, and St. Louis, Africa, and near Lisbon, Portugal, with connecting English lines to England, one directly traversing the high seas between Lisbon and English territory, and one touching at Vigo, Spain, at which point a German cable company has recently made a connection. The multiplication under English control of submarine cables has been the consistent policy of Great Britian, and to-day her cable communications connect the home government with all her colonies and with every strategic point, thus giving her exceptional advantages for commercial as well as for political purposes. The schedule blanks of rules of the English componies contain the following provisions: "The dispatches of the Imperial government shall have priority when demanded. The cable must not, at any station, employ foreigners, and the lines must not pass through any office or be subject to the control of any foreign government. In the event of war, the government (of Great Britain) may occupy all the stations on English territory or under the protection of Great Britain, and it may use the cable by means of its own employes."

It is not a pleasing reflection that in the actual situation the United States is at a great and embarrassing disadvantage. Meanwhile it would seem to

be the policy of the United States to overcome this disadvantage by the multiplication of submarine cables under American or other than English competing foreign ownership and control.

Although somewhat indeterminate, the policy of the United States in respect to the landing of foreign submarine cables, so far, at least, as the executive branch of the government is concerned, appears to be based chiefly upon considerations that shall guard against consolidation or amalgamation with other cable lines, while insisting upon reciprocal accommodations for American corporations and companies in foreign territory. The authority of the executive branch of the government to grant permission is exercised only in the absence of legislation by Congress regulating the subject, and concessions of the privileges heretofore have been subject to such further action by Congress in the matter as it may at any time take. Several bills are now pending in Congress relating to the landing of foreign submarine telegraph cables within the United States, and regulating the establishment of submarine telegraphic cable lines or systems in the United States. As this article is going to press it is reported that the President has refused permission to a foreign cable company to renew a cable terminus within the territory of the United States, and that the question raised as to the power of the federal government to deny admission to the cable will be referred to the attorney-general for an opinion. Meanwhile, the executive branch of the government holds to the doctrine that, in the absence of legislation by Congress, control of the landing and operation of foreign cables rests with the President. The question of the landing of foreign cables received some consideration from the late attorney-general in connection with an injunction suit brought by the United States against certain corporations engaged in placing on the coast of New York a cable having foreign connection. And he suggested for the consideration of Congress whether it would not be wise to give authority to some executive officer to grant or withhold consent to the entry of such foreign enterprises into this country on such terms and conditions as may be fixed by law.

The principal and most important submarine cables traversing or connecting the great oceans are owned and operated by private corporations or companies. They are in number 310, and their length in nautical miles is 139,754. The length of cables owned or operated by state governments is, in nautical miles, 18,132.

The policies of states, the movements of fleets and armies, and the regulation of the markets of the commercial world, depend upon devices, communications and orders that are habitually transmitted through the agency of submarine cables. In this view, the first aim is to safeguard from wanton destruction the delicate and expensive mechanism of these cables; the second is to restrain within the narrowest limits practicable interruptions in the operation of cables, even in the midst of hostilities; and the third is to encourage the establishment and extension of submarine cables owned and operated by American capital. All these ends may be advanced by the agreement of the powers to neutralize absolutely the submarine cable systems of the world.

—*Western Electrician*, January 8, 1898.

WARSHIPS AND TORPEDO BOATS.

The English Armored Cruiser Prince George.

The *Prince George* is a first class armored cruiser, and belongs to the

Majestic class, so called from the first ship constructed on this type, comprising in all nine vessels.

The purpose of England is to be able to take the offensive and to send her warships far from her coasts and as near the enemy's shores as possible. The program of the Admirality tends more and more to realize this object. Besides, her colonies are widely scattered and far removed, not only from each other but also from the metropolis; her ships are then in time of war expected to meet the enemy and to give battle many miles from the coast.

These requirements have imposed on the Admiralty the necessity of providing vessels with a very extended radius of action, consequently capable of carrying a large supply of fuel; this quality must be combined with that of speed, in order to be able to pursue an enemy and force him to fight, or to escape from a more powerful one.

These conditions are realized in a remarkable manner in the construction of the *Prince George*. Her displacement is 15,000 tons, and her speed exceeded 18 knots in the trials. Her bunkers can store 2,250 tons of coal.

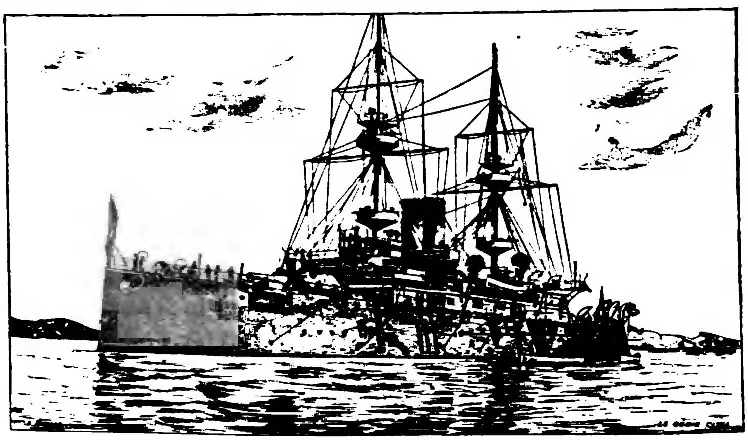

Fig. 1.

The maximum length is 425 feet: the length between perpendicular is 390 feet. Her maximum beam at the water line is 75 feet, but it decreases considerably from this point, for her sides tumble back "home" rapidly. Fullness of bilge is, moreover, one of the leading features of the ships of the *Majestic* type; it gives them a remarkable stability, the good results of which have been fully established in the case of the *Majestic* and *Magnificent*.

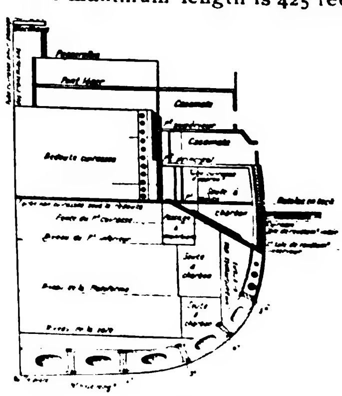

Fig. 2.

The *Prince George* has two screws each driven by a set of vertical triple-expansion engines of 6,000 horse-power each. The ship has six decks, see Fig. 2, viz.—1st, Shelter deck or boat deck; 2nd, Upper deck; 3rd Main deck or gun deck; 4th, Middle deck, at the level of the armored

deck; 5th, Lower deck; 6th, Platform deck. Above these decks run foot-bridges at a height of 75 feet above the water line.

The armored deck is three inches thick. It extends over a length of 252 feet and serves to protect the engines, boilers, magazines and other vital organs. Its sides are inclined and slope downwards to meet the ship's sides at the level of the lower deck. The greatest thickness of armor in 14 inches. The two masts of the *Prince George* are each provided with two fighting tops containing each three Hotchkiss 1.5-inch guns (3-pounders Q. F.) and electric search lights.

Armament.—The main battery of the *Prince George* consists of four 12-inch guns mounted in pairs in turrets fore and aft. These guns are mounted on revolving turntables, the whole being maneuvered by hydraulic power or, in case of emergency, by hand power by means of electric motors.

They are 40 calibers long and weigh 46 tons. They are hooped their entire length. This hooping is obtained by winding on bands or ribbons of steel wire, about ¼-inch wide by .06-inch thick, forming many superposed layers. The ultimate resistance to rupture of these bands is about 90 to 110 tons per square inch of cross section. Their tension varies according to the position of the layers from 30 to 60 tons per square inch. Their total weight of wire is about 12 tons and the total length very nearly 100 miles.

The weight of the projectile of these guns is 850 pounds. The weight of the charge is 167½ pounds. The initial velocity given to the projectile is 2,400 f. s., and at 2,000 yards it can penetrate 31¼ inches of wrought iron. Each piece can be fired four times in five minutes.

The *Prince George* carries, also, twelve 6-inch Q. F. guns mounted in armored casemates, eight of which are on the main deck and four on the upper deck. These pieces are also 40 calibers long, or 249¼ inches from breech face to muzzle.

Each gun consists of a steel tube whose interior diameter is exactly 6 inches; on the rear portion of this tube is contracted a second tube of steel and round this is wound the steel wire or ribbon similar to that of the 12-inch guns, the tension varying according to the principles formulated by Mr. Longridge. Over the wire is contracted a jacket on which are cut the steel keys designed to prevent any rotation of the gun during the advance of the projectile in the bore and to cause the gun to recoil in a straight line. Contracted and screwed on the rear end is the breech-ring, from the lower side of which projects an arm attached to the piston rod of the recoil cylinder.

The breech mechanism is of the usual Armstrong Q. F. interrupted screw system. It is remarkable for its rapidity of operation.

The lighter artillery of the *Prince George* consists of: 16 Hotchkiss quick-fire guns, 12 pounders, mounted on the main and upper decks; 12 Hotchkiss 1''.5 quick-fire guns, 3 pounders, mounted by threes in each of the tops; two 12-pounder, 8 cwt. quick-fire boat and field guns; finally 8 Maxim Machine guns, .45-inch caliber, mounted on high points on the superstructure.

The torpedo armament consists of four submerged tubes, two forward and two aft, and one above water tube at the stern. Twenty-two torpedoes are carried as a supply for battle.

Engines.—As has already been mentioned, the *Prince George* is propelled by a group of two vertical triple-expansion engines of 6,000 indicated horse-power each. The high pressure cylinder is 40 inches in diameter, the

intermediate 59 inches, and the low pressure 88 inches, the stroke being 4 feet, 3 inches.

The two main condensers have a total cooling surface of 13,500 square feet, and the two auxiliary condensers a total surface of 1,800 square feet. Each engine has one main air pump 18 inches in diameter. The main condensers are fed by four centrifugal pumps with impellers 3 feet 10 inches in diameter. These pumps are capable of throwing 1,200 tons of water each or 4,800 tons for all four in an hour.

Steam is furnished by eight single-ended cylindrical boilers with return tubes, having a total heating surface of 24,400 square feet, and a total grate surfaee of 820 square feet. There are four furnaces in each boiler. The steam pressure is 155 pounds per square inch.

There are 86 sets of auxiliary engines, besides the main engines, forming the complete outfit of the *Prince George*.

Electricity is supplied by three dynamos furnishing 600 amperes each, and feeding 930 incandescent lamps and six projectors.

The usual amount of coal carried is 920 tons, but the bunkers can hold a supply of more than 2,250 tons and with this amount of fuel on hand, the *Prince George* can steam for 19 days at a speed of about 15 knots without being obliged to replenish her supply.

During the four hours' trial (forced draught) the mean speed attained was 18.3 knots with a collective indicated horsepower of 12,253.

The crew, officers and sailors, numbers 758 men, but there are accommodations enough for 850 men.

—*Le Génie Civil*, October 2, 1897.

Translated by Andrew Hero, Jr., Lieutenant of Artillery.

Our Recently Purchased Warships.

It may safely be said that Armstrong's is the only shipbuilding yard in Europe where we could have purcnased two cruisers whose general features so closely approximate to the distinctive features of warship design as carried out in this country. From time immemorial American ships have been celebrated for their speed, and even more for the great power of their batteries. This was true in the days of the sailing frigate, when our ships were wont to crush their opponents with the weight of their superior gun-fire and their excellent marksmanship, and the same powerful batteries are found on the ships of our new navy. The principle is a good one. It has proved effective in the past, and it will do so in our new navy. The principle is a good one. It has proved effective in the past, and it will do so in our next naval war. The British *Magnificent* is half as large again as the *Indiana*, yet the latter carries by far the heavier battery. The British *Blake* and our own *Brooklyn* are about the same size, yet the American ship is greatly superior in the weight of its guns.

Of late years the celebrated Armstrong firm, in the North of England, has been turning out ships which have carried truly enormous batteries compared with the displacement of the ships, and, at the same time, have shown themselves phenomenally speedy. The most noted instance of this is the renowned *Esmeralda*, of the Chilean navy—not the old *Esmeralda*, of the late Chilean war, but the new cruiser of 7,000 tons displacement. This vessel carries no less than eighteen rapid-fire guns of the 8-inch and 6-inch sizes, besides eight 3-inch rapid-firers and ten 6-pounders. From these guns she could pour into an enemy from either broadside during the first few minutes

of the fight an amount of shell-fire whose total energy would be far greater than that of the biggest battleship afloat.

Our new acquisitions, the *Amazonas* and *Admiral Breu*, are the very latest product of this yard, and they exhibit the characteristic qualities of good speed and abnormally heavy battery, comparing in this respect with our own *Cincinnati*. The principle dimensions, etc., of these twin ships are as follows: Length 330 feet, beam 43 feet 9 inches, draught 16 feet 10 inches, displacement 3,600 tons. They have twin screws and engines, the horse-power being 7,500 and the speed 20 knots. Their normal coal supply is 700 tons, though they have stowage room for much more, and could therefore proceed at low speed far from our coal supply stations and reach hostile waters with a supply on hand. They are protected from stem to stern by a complete Harvey steel deck which is 3 inches thick where it curves down below the water-line along the sides. This 3 inches would present a sloping surface to the enemy, which would tend to deflect the projectiles. If they were not deflected the oblique 3 inches would be equal to a vertical wall of say 5 inches of Harvey steel. Before the shells could reach this deck, however, they would have to pass through 6 or 7 feet of coal which is stored in the wings of the ship abreast the engine and boiler rooms.

The battery, as we have said, is, for the size of the ship, very powerful. It is not only powerful in numbers, but owing to the fact that its guns are of the latest Armstrong pattern, they have vastly greater power for their size than guns that were built only four or five years ago. Armstrongs are the builders of the wirewound type of gun, which has shown results greatly superior to those obtained by the built-up type. Not only are these guns more powerful for their weight, but they have improved breech mechanism which enables them to be fired with greater rapidity. The following comparison of the Armstrong ship with one of the same size and type built for the British navy from government plans shows clearly the greater fighting power of the former. The figures are taken from the official tables of the British navy and the firm in question. The speed of fire is that actually obtained by crews on board ships in commission. The *Intrepid* is one of a class of thirty ships built under the late Naval Defense Act, and though not so up-to-date as the *Amazonas*, may be considered as a good example of the average protected cruiser of the existing navies of the world.

COMPARISON OF TOTAL ENERGY OF FIRE DURING ONE MINUTE FROM EITHER BROADSIDE.

	Number and Size of Guns.	Muzzle Energy.	Shots per Minute from Each Gun.*	Total Energy.
"Amazonas," 1897	Four 6-inch.	4,840 foot tons.	6	116,160
	Two 4.7-inch.	2,158 " "	12	51,792
	Five 2.24-inch.	280 " "	20	28,000
				195,952
"Intrepid," 1892	Two 6-inch.	3,356 " "	5	33,560
	Three 4.7-inch.	1,494 " "	10	44,820
	Four 2.24-inch.	137 " "	20	10,960
				89,340

* This rapidity of fire would not of course be maintained for any length of time in the excitement and slaughter of a modern sea fight. The figures, however, serve for the present comparison.

From this comparison then it is evident that although the two ships are of the same size, the *Amazonas* can deliver from her broadside more than double the energy of shell fire that the *Intrepid* can, although the latter ship was built only five years in advance of the former—such is the rapidity with which naval science and construction advances.

Foot-ton energy, which we have chosen as the basis of comparison, is the product of weight or mass by velocity; and as the weight of the shells for each caliber of gun is the same, the increase in energy is due to the very high velocities of the *Amazonas* guns as compared with those of the *Intrepid.* Thus the 6-inch rapid-fire Armstrong gun has a velocity of 2,642 feet per second, against 2,200 feet for the British naval gun; the Armstrong 4.7-inch gun has 2,630 feet per second, the naval gun 2,188 feet, and so on through the smaller calibers.

As further illustrating the development in naval design in a brief five years, we append a further comparison:

	Thickness of Deck.	Horse Power.	Speed.	Coal Capacity.
"Amazonas".	3 inches.	7,500	20.00	700
"Intrepid".	2 "	9,000	19.75	400

We find then that by the use of improved materials and methods the naval architect has been able, using the same capital (3,600 tons displacement), to produce a ship having superiority on every point of comparison—a ship with more speed, with 50% better protection, 80% larger coal capacity, and over 100% more powerful armament.

We can imagine no more convincing argument for a systematic and continuous program of naval shipbuilding than is presented by a study of these figures. The *Intrepid* was one of seventy-two warships which were authorized in a single appropriation and built with a rush. The present policy in England and Europe generally is to build so many ships each year, and thereby insure that each year's ships shall embody all the latest improvements. A similar policy will undoubtedly be adopted in this country, and its effect will be to bring the general average of the navy more thoroughly up to date.

BOOK REVIEWS.

Forty-six Years in the Army. By Lieutenant-General John M. Schofield. New York: The Century Co., 1897. Pp. 577. $3.00.

The work before us is a soldier's calm and dispassionate narrative of the great events transpiring under his notice, during a career that was more than usually varied and interesting. A mind naturally analytical necessarily gives corresponding color to the work it undertakes, and such is the case with General Schofield's narrative, indeed, this tendency in him to subject motives and actions to a careful analysis has given rise to serve criticism of his book, on the ground that he expresses too perfect a satisfaction with his own acts and measures. But, in our opinion, this impression results mainly from the author's method of treatment of the subject, for the *facts* are set forth with impartiality, and any one can form his own conclusions, irrespective of the author's.

Personal memoirs are always a charming form of literature, particularly when they relate to great events, or important personages, and are written by one who has had, in addition to other advantages, a good general education. General Schofield was always essentially a student, and this natural bent explains his ability to fill with credit such a variety of positions in life.

Of his Cadet studies he says:

"I devoted only a fraction of the study hours to the academic course—generally an hour, or one and a half, to each lesson. But I never intentionally neglected any of my studies. It simply seemed to me that a great part of my time could be better employed in getting the education I desired by the study of law, history, rhetoric, and general literature. Even now I think these latter studies have proved about as ureful to me as what I learned of the art and science of wâr; and they are essential to a good general education, no less in the army than in civil life. I have long thought it would be a great improvement in the Military Academy if a much broader course could be given to those young men who come there with the necessary preparation, while not excluding those comparatively young boys who have only elementary education."

Anecdotes of the great men who surrounded the author, as well as estimates of their characters, are a legitimate and entertaining part of his memoirs. Even in the Cadet days we find such of men like McPherson and Hood, who figured so conspicuously so near the author in the great war that was to come.

General Schofield, like General Grant, began his service in the Civil War in the West, and his name is intimately associated with the early struggle in Missouri and Arkansas, where he did heroic duty not only in the field, but also in preserving peace and controlling popular feelings, and, above all, in helping to keep these two states in the Union. Incidentally, we have here excellent character sketches of Lyon, Blair, Frémont and others. When he obtained command of the Department of the Missouri his prompt action in sending all the troops he could spare to Grant at Vicksburg gained him the confidence of both Lincoln and Grant. The party quarrel in Missouri and

Kansas, during the summer and fall of 1863, which he kept under control by the most persistent efforts, furnished an experience perhaps more remarkable and trying than that of any other officer of the regular army.

In the early part of 1864 he was assigned to the command of the Army of the Ohio and took part in the Atlanta campaign. His account of this campaign partakes somewhat of the character of a criticism of Sherman's *Memoirs*, and, while he expresses great admiration and affection for that much-loved warrior, he does not hesitate to point out defects of organization or strategy. The unwieldiness of Thomas's large army is clearly shown, and McPherson's conduct at Resaca is explained in a way very different from Sherman's:

"One half of Sherman's infantry was ample for the demonstration in front of Dalton. At least one-half should have been sent through Snake Creek Gap to strike the enemy's rear. There was no necessity to attack Resaca at all, and experience has shown what terrible losses a small force in a strongly fortified position may inflict upon a very large attecking force. Two or three brigades could have invested Resaca, with the garrison it then held, while a force large enough to hold its ground against Johnston's whole army could have been put upon the railroad between Resaca and Dalton. The result would then, in all probability, have been what Sherman expected. Indeed, the fate of Johnston's army might perhaps have been decided then and there.

"Sherman certainly cannot be suspected of wishing to do injustice to the memory of McPherson, for he respected and loved him most highly, and mourned his death with evident sincerity. But I think he is in error in saying that 'at the critical moment McPherson seems to have been a little timid.' I believe the error was Sherman's, not McPherson's."

The recital of the military movements in this campaign is enlivened by many personal anecdotes.

After the fall of Atlanta, General Schofield was ordered back to assist Thomas at Nashville. The account of the battles of Franklin and Nashville, to be understood, must be carefully studied: no mere summary would be satisfactory. General Schofield's dissatisfiaction with the slowness and inaction of Thomas appears to have been well founded, and his estimate of this great soldier of the war, so deeply beloved by all who were thrown in contact with him, so much respected by friend and foe, both as a man and a general, while it will not in all probability be satisfactory to his intimate friends and strong admirers, yet seems both fair and just.

During the early reconstruction days General Schofield was commander of the Department of North Carolina, but in the latter part of 1865 he was sent to Paris on a diplomatic mission to induce the French to withdraw from Mexico, a mission which proved entirely successful in accomplishing its immediate object and in maintaining peace and good feeling. On his return he was again busy with reconstruction, this time in Virginia, and during the impeachment trial of President Johnson he served as Secretary of War, and he laid down the war portfolio "without having incurred censure from either party."

The author's experiences as Department Commander, which involved the Canby massacre and the Modoc War, as Superintendent of the Military Academy at West Point, as Division Commander, and finally as Commander of the Army, were very various and full of interest. Though often harshly and unjustly dealt with, he was patient under his difficulties, yet firm in his assertion of the truth.

Today, when he should be enjoying the well-earned repose of retirement from active service, he is the leader of the army of reserve, which is now organizing for the national defence. J. P. W.

The History of our Navy from its orign to the present day. 1775-1897. John R. Spears. Four volumes. New York: Charles Scribner's Sons. 1897.

What could be more inspiring than the recital of the gallant deeds of our Navy in the past, what prouder title to a high position among the nations of the world, have we, what higher examples of patriotism and devotion to duty can history show? Since its origin, nearly a century and a quarter ago, it has illuminated the pages of our history with a glory that any nation may be proud of, and its past gives promise of a future that will not dim the lustre of its record.

The first American navy consisted of "eight vessels, of which two only were ships, and the others were brigs or smaller, and all were lubberly merchantmen. All told, this squadron mounted just 114 guns, of which the largest was a cannon that could throw a round cast-iron ball weighing nine pounds. Even of these there were less than fifty. And the powder to load them and the muskets with which the seamen had been armed were all borrowed from the commonwealth of Pennsylvania.

"Yet this puny squadron, 'poor and contemptible, being for the greater part no better than whale boats,' as a British authority truly says, was to go to sea to make war—against what force does the reader suppose? A navy of 112 ships, carrying 3,714 guns, of which force no less than seventy-eight ships, carrying 2,078 guns, were either already on the American coast or under orders to go there."

John Paul Jones raised the first American naval ensign on the flagship of this squadron.

Among the earliest of our naval heroes are Captain Nicholas Biddle, "one of the most heroic men known to the American naval register," Captain John Barry, Captain Lambert Wickes, "who first flaunted the American flag in British waters and took British ships within sight of the British coasts," John Paul Jones, of immortal fame, and Benedict Arnold, who, although an army officer, was given the task of preparing a flotilla on Lake Champlain to stop the invasion of Sir Guy Carleton, and when the enemy was met "no more desperate conflict is recorded in naval annals than that of Arnold that day."

From these small beginning the history carries us along through the Revolution, the War of 1812, the Civil War, to the present day, when our navy is again beginning to take its proper place, in size and importance, among the navies of the world.

The descriptions of the actions are spirited and graphic, and, by way of fairness, the account of both sides is usually given where there is a difference of opinion or in the statement of facts. The interest is varied by interspersing anecdotes of the great naval heroes, notes on the pay of the navy and life at sea in the different epochs.

As a history it is full and complete, and yet of absorbing interest. There is no mass of details to weary the mind, but every page sparkles with the fire of some soul-inspiring action. The illustrations (of which there are over four hundred), not only add greatly to the value and beauty of the work, but are in themselves a most interesting collection, many being from old prints, famous paintings, etc.

All indications point to the fact that the United States will again become a great naval power in the not far distant future. The interior of the country has been developed so rapidly of late that the nation's eyes are already turning outward for the development of her commerce, and for other fields of action. It behooves us then to study the past history of our navy in order that we may proceed intelligently in building it up in the future, and the work before us presents that history in attractive form, setting forth the lessons we ought to learn, and the mistakes we ought to avoid, in unmistakable clearness and with convincing force. J. P. W.

The Interest of America in Sea Power Present and Future. By Captain A. T. Mahan, United States Navy. Boston: Little, Brown and Company, 1897.

This volume collects in book form a series of articles originally published in the *Atlantic Monthly*, the *Forum*, the *North American Review*, and *Harper's New Monthly Magazine*. The unity of treatment is indicated in the title of the book.

These articles, although generally written with the author's clearness and charm of expression, yet differ considerably in quality. The first relates to the growing tendency of the United States to look outward, to utilize her position between the two Old Worlds and the two great oceans, and the concluding paragraph is significant as to a proper beginning for this expansion.

"In conclusion, while Great Britain is undoubtedly the most formidable of our possible enemies, both by her great navy and by the strong positions she holds near our coasts, it may be added that a cordial understanding with that country is one of the first of our external interests. Both nations doubtless, and properly, seek their own advantage; but both, also, are controlled by a sense of law and justice, drawn from the same sources, and deep-rooted in their instincts. Whatever temporary aberration may occur, a return to mutual standards of right will certainly follow. Formal alliance between the two is out of the question, but a cordial recognition of the similarity of character and ideas will give birth to sympathy, which in turn will facilitate a co-operation beneficial to both; for if sentimentality is weak, sentiment is strong."

The next article treats of the Hawaiian question in a masterly way from the standpoint of evolution, the gist of which lies in these words: "The issue cannot be dodged. Absolute inaction in such a case is a decision as truly as the most vehement action. We can now advance, but, the conditions of the world being what they are, if we do not advance we recede; for there is involved not so much a particular action as a question of principle, pregnant of great consequences in one direction or in the other."

The third essay considers the Isthmus in its relation to sea power and the fourth the author's views on a possible Anglo-American reunion. In these first papers the idea of cementing our friendship with England is dominant, and for that reason they form a group by themselxes.

The next three articles discuss the future of the United States as a sea-power, and the closing paper considers the strategic features of the Gulf of Mexico.

There is not an article in the series that is not well worth careful study by every American citizen. The author's views are based on broad principles which all thoughtful and trained men admit, and the full understanding of the subjects presented is absolutely essential to a clear comprehension of our proper policy. J. P. W.

All the World's Fighting Ships by Fred T. Dane. Boston: Little, Brown & Co. 1898. Pp. 218.

This invaluable work, containing illustrations of all the typical war-ships and torpedo-boats of the world's navies, appears most opportunely. Its aim is to supply details not usually included in other naval annals, and as the descriptive part is printed in four different languages, it has a great field of interest and usefulness. The illustrations have been made from photograph first drawing them in pen-and-ink for the sake of greater clearness in the production. No pains have been spared to insure accuracy, and the dat have in all cases been revised by experts (naval officers and ship builders) Every page is covered with illustrations, and the brief descriptions give the principal dimensions, armament, armor, speed, and other information. The system of classification and reference is simple, convenient and satisfactory. At the end of the volume is given a list of ships launched, and at present completing for sea, the coal endurance of various types, and lastly diagrams (to the same scale) showing the arrangement and thickness of the armor of every ship having vertical armor.

The author and publishers are to be congratulated on the result of their efforts, and we can only say, in conclusion that in our opinion a copy of this work should be at every sea-coast artillery post and on board every vessel in the navy.

J. P. W.

Aide-Mémoire de l'Officier de Marine. 1898. Durassier. Continué par Valentino. Paris: Henri Charles-Lavauzelle.

This well-known annual, replete with valuable information in regard not only to the French navy, but also to all the world's navies, appears once more in its usual dress, and with its contents similar to those of other years, but more complete than ever before.

Detailed descriptions of the hull, machinery, armor and armament of all modern war-ships and torpedo-boats are given in separate articles for each nation, and the data collected in tabulated form, convenient for reference and inspection.

The great interest taken in navies and war-ships at the present time, in consequence of the troubles in the East and the gathering clouds in the West Indies, causes the appearance of this annual to be looked for with more than ordinary interest. The present volume fully meets all requirements, and upholds the well-earned reputation of this standard book of reference.

J. P. W.

Der Griechisch-türkische Krieg des Jahres 1897. Nach officiallen Quellen von einem höheren Offizier. Berlin: Schall und Grund. M. 5.

This account of the recent war between Greece and Turkey, by a field or general officer in the German army, presents the first connected account that has appeared in book form, and is based on official information. The style is somewhat popular, but at the same time the operations are described with sufficient detail to satisfy the military student, and the strategical or tactical criticisms, though brief, are clear and sound.

The volume opens with an excellent account of the organization and character of the two armies and navies, and this is followed by a description of the field of operations, which, taken in connection with the six maps accompanying

the volume, present a very satisfactory picture of the country in which the events were enacted.

After the capture of the Meluna Pass and Gritzovalli Redoubt, the account proceeds as follows:

"On the 24th of April the Turkish commander-in-chief experienced a great surprise. The subdivisions sent out to the front, instead of meeting the enemy in his strong and well-arranged position, discovered that he had withdrawn in the direction of Larissa, having vacated all his positions in the mountain. The Greeks had, indeed, retired during the night under an order from Crown Prince Constantine, and at daybreak had entirely disappeared from view. The little town of Tyrnavos was immediately occupied by the Hairi Pasha Division advancing from Damassi, and the headquarters was transferred to Kazaklar.

"The Hakki Pasha Division, advancing from Dissikato, received orders to move on Trikkala, and to occupy this important railroad point, as well as the railroad bridge over the Salambria.

"When the Turks entered Tyrnavos they saw before them a town almost entirely deserted by its inhabitants, in which, although it had been occupied for weeks by Greek troops, there were large quantities of ammunition and provisions. Of the latter, for example, crackers, sardines, wine, brandy, flour etc., were found. Edhem Pasha at once appointed a commander with instructions to post sentinels over the shops with orders to stop all plundering. In strict obedience to these orders the soldiers brought in large quantities of wine, without any Moslem of them all so much as thinking of touching any of it.

"Gradually, Greek soldiers coming out of their hiding places appeared, begging for their lives in fear and trembling, and telling how they had been persuaded that all the Greeks that fell into the hands of the victors would suffer death. They were quieted and fed, and then set free. In the very best of order and system the sentinel and patrol service was then instituted and conducted; and the churches were treated with particular consideration and respect."

The same order and discipline marked the occupation of the other towns by the Turks.

The entire campaign in Thessaly is set forth with equal simplicity of language and clearness of description. Everywhere the poor character of the Greeks, as soldiers and sailors, is in evidence: in Thessaly, in Epirus and in the operations at sea. Everywhere the Turks showed and proved themselves capable of conducting an offensive campaign, with the same energy and devotion to duty which they were known to possess in a defensive campaign.

This comparatively brief account of a short campaign is well worth studying, not so much for the lessons in strategy and tactics which it teaches, as for the more general lessons in preparedness, training and discipline.

J. P. W.

Kriegsgeschichtliche Beispiele aus dem deutsch-französischsn Kriege von 1870/71. Von Kunz, Major a. D. Heft 5. Berlin: E. S. Mittler und Sohn. 1897. Mark 2.

The fifth number of this instructive series of historical incidents from the Franco-German war of 1870-71 treats of French cavalry attacks on German infantry and artillery. Eighteen separate actions are described, the most

important being the great cavalry attacks at Sedan. The great number of these attacks and the almost uniform results make the conclusions particularly valuable. With the exception of gaining a little valuable time, not one of them had the slightest effect on the general course of the events transpiring. The German infantry resisted successfully every French cavalry attack, not only when the former was victorious, but even when its tactical units were broken up, and there was hardly a single officer left unwounded in the firing line.

These attacks were all frontal, in a single line or in a succession of lines, the French cavalry never succeeding in gaining the flanks of the German infantry.

The conclusions to be drawn from the experiences here cited may be summed up as follows:

1. A frontal attack by cavalry against unshaken infantry can be justified only when the gaining of a little time is absolutely necessary in order to save a defeated army. Any other result is not to be expected, indeed, is practically excluded.

2. An attack on the flanks of unshaken infantry promises greater success than a frontal attack in line or in echelons. With the generally adopted deep formation of the infantry of today, however, even such a flank attack can have but a passing effect, and must end with the almost complete annihilation of the attacking cavalry.

3. When the enemy is beaten, with heavy losses, then strikes the hour for the victor's cavalry,—this is its true field of glory.

This number forms a valuable addition to the series, and treats the subject it discusses in the same thorough manner as the other subjects are treated in preceding numbers.

J. P. W.

Preparatory Battle Formations. By Major-General H. Bengough, C. B. London and Aldershot: Gale and Polden, Ltd. One Shilling.

The French have lately laid great stress on small columns in those portions of the line of battle not directly under infantry fire, and this idea has been adopted by the English.

The pamplet before us is a development of this idea, the principle being to to form in section columns at extended order interval, and the advantages claimed are great elasticity, facility of forming to the front rapidly, or showing a front to a flank, power to change direction of advance readily, offering a difficult target to artillery, and affording facilities for the passage of our own cavalry and artillery.

The proposed system deserves careful study: Major-General Bengouch is a practical soldier, firm in his conviction, and fearless in the expression of his views, yet based on sound principles.

J. P. W.

BOOK NOTICES.

[These books will be fully *reviewed* as space becomes available.]

Die Heere und Flotten der Gegenwart. Erster Band: Deutchland. Berlin: Schall und Grund. Mark 15.

Die Lehre vom Schuss und Schusstafeln. Hauptmann Heydenreich. Berlin: E. S. Mittler und Sohn. 1898. Mark 6.

Condiciones que debe llenar el Material de Artilleria de Campaña. D. José de Lossada y Canterac. Madrid: Memorial de Artilleria. 1898.

Petit Dictionnaire Militare, par W. Stavenhagen. Premierè Partie: Français-Allemand. Berlin: Librairie Militaire de R. Eisenschmidt. 1897. Mark 5.50.

INDEX TO CURRENT ARTILLERY LITERATURE.

PERIODICALS CITED.

Abbreviations employed in index are added here in brackets.

All the periodicals are preserved in the Artillery School Library, Fort Monroe, Virginia.

ENGLAND.

Aldershot Military Society. *Occasional.*
Aldershot. Copies 6d each.

Arms and Explosives. [*Arms and Ex.*] *Monthly.*
Effingham House, Arundel Street, Strand, London, W. C. Per year 7 *s.*

Army and Navy Gazette. [*A. and N. Gaz.*] *Weekly.*
3 *York Street, Covent Garden, London. Per year* £1 12 *s* 6 *d.*

Canadian Military Gazette. [*Can. Gaz.*] *Fortnightly.*
Box 2179 *Montreal, Canada. Per year* $2.00.

The Engineer. [*Eng.*] *Weekly.*
33 *Norfolk Street, Strand, London. Per year* £2 6 *d.*

Engineering. [*Eng'ing.*] *Weekly.*
35-36 *Bedford Street, Strand, London, W. C. Per year* £2 6 *d.*

Journal of the Royal United Service Institution, [*Jour. R. U.S.I.*] *Monthly.*
17 *Great George Street, London, S. W. Per year* 24 *s.*

Journal of the United Service Institution of India. [*Jour. U. S. I. India*] *Quarterly.*
Simla, India. Per year $2.50.

Photographic Journal. [*Photo. Jour.*] *Monthly.*
12 *Hanover Square, London.*

Proceedings of the Institution of Civil Engineers. [*Proceedings I. C. E.*]
25 *Great George Street, Westminister, London.*

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[*Proceedings I. M. E.*] 19 *Victoria Street, Westminister, London.*

Proceedings of the Royal Artillery Institution. [*Proceedings R. A. I.*] *Monthly.*
Woolwich, England.

Professional Papers of the Corps of Royal Engineers.
[*Prof. Papers Corps Royal Eng'rs.*]
Chatham, England.

Review of Reviews. [*Rev. of Rev. Austral.*] *Monthly.*
169 *Queen Street, Melbourne, Australia. Per year* 11 s. 6 d.

Transactions of the Canadian Institute. [*Trans. Canadian Inst.*]
58 *Richmond Street, Toronto, Canada.*

Transactions of the Canadian Society of Civil Engineers.
[*Trans. Canadian Soc. C. E.*]
Montreal, Canada.

Transactions of the East of Scotland Tactical Society.
[*Trans. E. of S. Tactical Soc.*]
51 *Hanover Street, Edinburgh, Scotland.*

Transactions of the Institute of Naval Architects.
[*Trans. Inst. Naval Architects.*]
5 *Adelphi Terrace, London, W.C.*

United Service Gazette. [*U. S. Gaz.*] *Weekly.*
46 *Catherine Street, Strand, London, W.C. Per year* £1 10*s* 6*d.*

FRANCE.

L'Avenir Militaire. [*Avenir.*] *Semi-weekly.*
13 *Quai Voltaire, Paris. Per year* 18 *Fr.*

Le Génie Civil. [*Génie C.*] *Weekly.*
6 *Rue de la Chaussée d'Antin, Paris. Per year* 45 *Fr.*

Journal des Sciences Militaires. [*Sciences Militaires.*] *Monthly.*
Rue et Passage Dauphine 30, *Paris. Per year* 40 *Fr.*

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23 *Rue Madame, Paris. Per year* 30 *Fr.*

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[*Ingénieurs Civils.*] *Monthly.*
10 *Cité Rougemont, Paris. Per year* 36 *Fr.*

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5 *Rue des Beaux-Arts, Paris. Per year* 22 *Fr.*

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Berger Levrault et Cie, Rue des Beaux-Arts 5, *Paris. Per year* 33 *Fr.*

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37 *Rue de Bellechasse, Paris. Per year* 27 *Fr.*

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8 *Rue Saint-Dominique, Paris. Per year* 27 *Fr.*

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11 *Place Saint André-des-Arts, Paris. Per year* 25 *Fr.*

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11 *Place Saint André-des-Arts, Paris. Per year* 25 *Fr.*

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55 *Rue de Chateaudun, Paris. Per year* 30 *Fr.*

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Darmstadt. Per year 24 *M.*

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Beiheft zum Militaer-Wochenblatt. [*Beiheft.*]
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Deutsche Heeres-Zeitung. [*Heeres-Zeit.*] *Semi-weekly.*
Wilhelmstrasse 15, *Berlin. Per year* $6.00.

Internationale Revue. [*Int. Revue.*] *Monthly.*
Blasewitzer Strasse 15, *Dresden. Per quarter* 6 *M.*

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Mohren Strasse, 19, *Berlin*, *W.* 8. *Per year* 32 *M.*

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Rathenow, *Germany. Per year* $4.50.

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AUSTRIA.

Mittheilungen ueber Gegenstaende des Artillerie und Genie-Wesens.
[*Mitth. Art. u. G.*] *Monthly.*
Wien, *VI*, *Getreidemarkt* 9. *Per year* 1 *Fl.* 50 *Kr.*

Mittheilungen aus dem Gebiete des Seewesens. [*Seewesens.*] *Monthly.*
Pola. Per year 14 *M.*

Organ der Miltaer Wissenchaftlichen Vereine. [*Vereine.*]
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SWITZERLAND AND BELGIUM.

Allgemeine Schweizerische Militaer-Zeitung. [*A.S.M. Zeitung.*] *Weekly*
Basel, *Switzerland. Per year*, 8 *Fr.*

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Frauenfeld, *Switzerland. Per year* 5 *Fr.*, *plus postage.*

Revue de l'Armée Belge. [*A. Belge.*] *Bi-monthly.*
22 *Rue des Guillemins*, *Liège*, *Belgium. Per year* 13 *Fr.*

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Frauenfeld, Switzerland. Per year 8 *Fr.* 20 *centimes.*

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Boletin del Centro Naval. [*Boletin.*] *Monthly.*
438 *Alsina, Buenos Aires, Argentina Republica. Per year* $11.00.

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Casilla num. 852, *Valparaiso, Chili.*

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Farmacia, num. 13, *Madrid, Spain. Per year, U. S.,* $3.40.

El Porvenir Militar. [*Porvenir.*] *Weekly.*
258 *Calle Montevideo, Buenos Aires, Argentina. Per year* 10 $ $\frac{m}{n}$.

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Revista Cientifico-Militar. [*Cientifico M.*] *Semi-monthly.*
5 *Calle de Cervantes, Barcelona, Spain. Per year* 32 *Fr.*

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Revista de Engenheria Militar. [*Engenheria Mil.*] *Monthly.*
27 *Rua Nova do Almada, Lisbon, Portugal. Per year* 1 $ 800 *réis.*

Revista do Exercito e da Armada. [*Exercito.*] *Monthly.*
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56 *Calle de Alcalá, Madrid, Spain. Price U. S.* $4.45.

Revista Maritima Brazileira. [*R.M. Brazil.*] *Bi-monthly.*
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Revista Militar. [*R. Mil. Portugal.*] *Semi-monthly.*
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Revista Militar. [*R. Mil. Chile.*] *Monthly.*
Santiago, Chili.

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Stockholm, Sweden. Per year, U. S., $1.75.

De Militaert Gids. [*M. Gids.*] *Bi-monthly.*
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Copenhagen, Denmark. Per year, U. S., $2.50.

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Furschtatskaia Ulitza, St. Petersburg, Russia.

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Rivista di Artiglieria é Genio. [*R. Artig.*] *Monthly.*
Tipografia Voghera Enrico, Rome. Per year 30 *L.*

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Rome. Per year 25 *L.*

UNITED STATES.

American Engineer and Railroad Journal. [*Eng. and Rail. Jour.*] *Monthly.*
140 *Nassau Street, New York City. Per year* $2.00.

American Journal of Mathematics. [*Jour. Math.*]
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American Machinist. [*Amer. Mach.*] *Weekly.*
256 *Broadway, New York City. Per year* $3.00.

American Manufacturer and Iron World. [*Man. and Iron World.*] *Weekly.*
59 *Ninth Street, Pittsburgh, Pa. Per year* $4.00.

Annual of the Office of Naval Intelligence. [*Naval Intelligence.*]
Washington, D. C.

Army and Navy Journal. [*A. and N. J.*] *Weekly.*
New York City. Per year $6.00.

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Washington, D. C. Per year $3.00.

Bulletin of the American Mathematical Society. [*Bulletin Math. Soc.*]
University Heights, New York City.

Cassier's Magazine. [*Cas. Mag.*] *Monthly.*
World Building, New York City. Per year $3.00.

Digest of Physical Tests. [*Digest.*] *Quarterly.*
1424 *N. 9th Street, Philadelphia. Per year* $1.00.

Electrical Engineer. [*Elec. Eng.*] *Weekly.*
203 *Broadway, New York City. Per year* $3.00.

Electrical Engineering. [*Elec. Eng'ing.*] *Semi-Monthly.*
443 *The Rookery, Chicago, Ill. Per year* $1.00.

Electrical Review. [*Elec. Rev. N. Y.*] *Weekly.*
41 *Park Row, New York City. Per Year* $3.00.

The Engineer. [*Eng. N. Y.*] *Fortnightly.*
106-108 *Fulton Street, New York City. Per year* $2.50.

Engineering Magazine. [*Eng'ing. Mag.*] *Monthly.*
120-122 *Liberty Street, New York City. Per year* $3.00.

Engineering News and American Railroad Journal.
[*Eng'ing News and R.R. Jour.*] *Weekly.*
220 *Broadway, New York City. Per year* $5.00.

Engineering and Mining Journal. [*Eng. and Min. Jour.*] *Weekly.*
253 *Broadway, New York City. Per year* $5.00.

The Iron Age. [*Iron Age.*] *Weekly.*
96-102 *Reade Street, New York City.* *Per year* $4.50.

Journal of Electricity. [*Jour. Elec.*] *Monthly.*
421 *Market Street, San Francisco, Cal.*

Journal of the American Chemical Society. [*J. Chem. S.*] *Monthly.*
Easton, Pa. *Per year* $5.00.

Journal American Society of Naval Engineers. [*A.S.N. Egrs.*] *Quarterly.*
Navy Department, Washington, D. C.

Journal of the Association of Engineering Societies. [*Eng. Soc.*] *Monthly*
257 *South Fourth Street, Philadelphia.* *Per year* $3.00.

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Philadelphia, Pa., Per year $5.00.

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Governor's Island, New York City. *Per year* $4.00.

Journal of the U.S. Cavalry Association. [*Jour. U. S. Cavalry*] *Quarterly.*
Fort Leavenworth, Kansas.

Journal of the Western Society of Engineers. [*W. Soc. Eng.*] *Bi-monthly.*
1737 *Monadnock Block, Chicago, Illinois.* *Per year* $2.00.

Marine Review. [*Mar. Rev.*] *Weekly.*
Cleveland, Ohio. *Per year* $2.00.

Military Information Division. [*Mil. Information Div.*] *Occasional.*
War Department, Washington, D. C.

Notes on Naval Progress. [*Naval Intelligence.*] *Occasional.*
Navy Department, Washington, D. C.

Pennsylvania Magazine of History and Biography. [*Penn. Mag. of Hist.*] *Quarterly.*
13 *Locust Street, Philadelphia.* *Per year* $3.00.

The Photographic Times. [*Phot. Times.*] *Weekly.*
60 *and* 62 *E.* 11*th Street, New York City.* *Per year* $5.00.

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Cornell University, Ithaca, New York. *Per year* $3.00.

Popular Science Monthly. [*Pop. Sc. Mo.*] *Monthly.*
72 *Fifth Avenue, New York City.* *Per year* $5.00.

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104 *South Fifth Street, Philadelphia, Pa.*

Proceedings of the U. S. Naval Institute. [*Naval Inst.*] *Quarterly.*
Annapolis, Md. *Per year* $3.50.

Public Opinion. [*Pub. Opin.*] *Weekly.*
New York City. *Per year* $2.50.

Review of Reviews. *Monthly.*
13 *Astor Place, New York City.* *Per year* $2.50.

The Scientific American. [*Scien. Amer.*] *Weekly.*
361 *Broadway, New York City.* *Per year* $3.00.

Shooting and Fishing. *Weekly.*
293 *Broadway, New York City.* *Per year* $3.50.

Technology Quarterly. [*Tech. Quart.*] *Quarterly.*
Mass. Inst. of Tech., Boston, Mass. Per year, $3.00.

Transactions American Institute of Electrical Engineers.
[*Inst. Elec. Eng'rs.*] *Monthly.*
26 *Cortlandt Street, New York City. Per year* $5.00.

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[*Trans. Inst. Min. Eng'rs.*]
P. O. Box 225, *New York City.*

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[*Trans. A. S. Civil Eng'rs*]
127 *East* 23*d Street, New York City.*

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[*Trans. A. S. Mech. Eng'rs.*]
12 *West* 31*st Street, New York City.*

Transactions of the Society of Naval Architects and Marine Engineers.
[*Naval Architects and Marine Eng'rs.*]
12 *West* 31*st Street, New York City.*

Western Electrician. [*West. Elec.*] *Weekly.*
510 *Marquette Building, Chicago, Illinois. Per year* $3.00.

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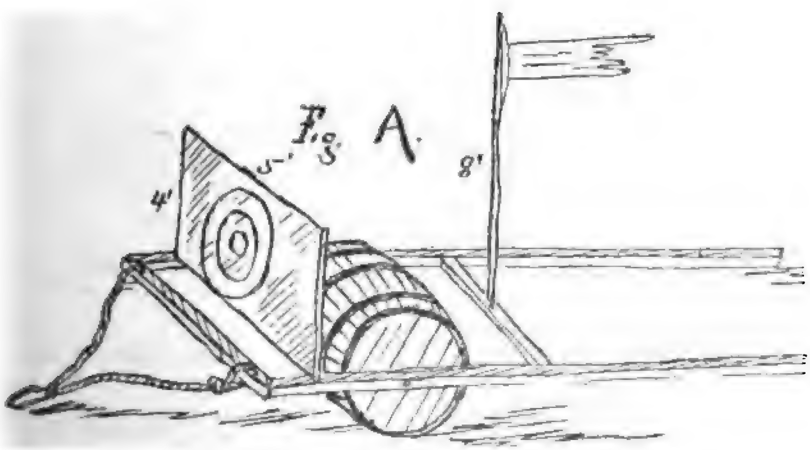
MOVING TARGETS IN USE IN THE LIGHT ARTILLERY OF ENGLAND, GERMANY, FRANCE, ITALY, AND SOME FORMS RECENTIY TRIED BY THE LIGHT ARTILLERY BATTALION AT FORT RILEY, KANSAS.

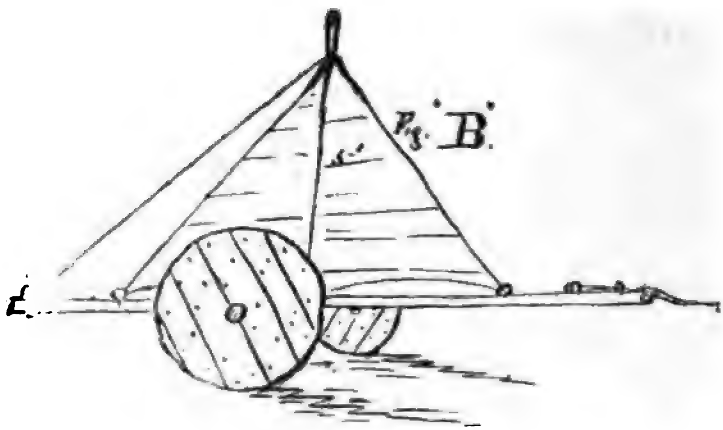
In a pamphlet entitled "Instruction for Practice, horse, field and Mountain Artillery 1896," four styles of moving targets and two of surprise targets are described for use in the English service.

Target "A" consist of a half tun vat or other cask rolling between two pieces of timber or shafts about 20 feet long carrying a flag eight feet high and a rectangular target in front about three by four feet in size. (See sketch "A").

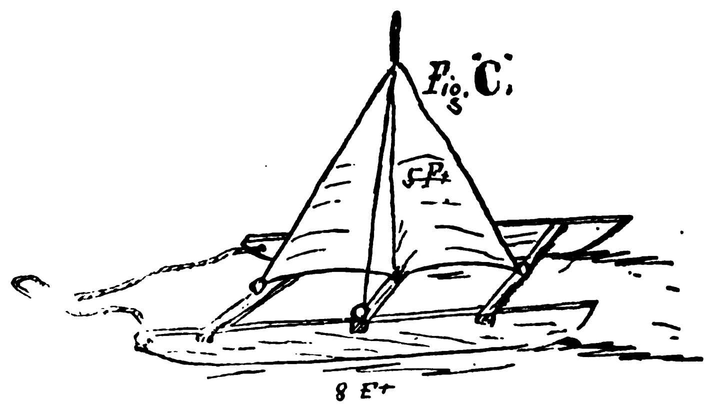


Target "B" consists of a two-wheeled truck, 6 foot axle, wheels 3 feet 6 inches in diameter, (board) tongue ten or eleven feet long to which a tow line is attached.

The frame-work carries a triangular canvas target 5 feet high and five feet base. This target is recommended for smooth sandy ground. (See sketch "B").



Target "C" is similar to target "B" except that it is mounted on two board runners 8 feet long an l 1 foot high. The tow line for these targets "A," "B," "C" is a 2 inch rocket or coir line. (See sketch "C").



Target "D," Colonel Richardson's pattern, consists of a frame platform 13 feet wide and 10 feet long made on 4 two by four pieces. Between the front ends of the two inside pieces is placed a cask about 4 feet long and 2 feet 6 inches in diameter revolving on an axis so that it will act as a roller. The rear part of the frame drags on the ground. This platform carries a vertical frame 7 feet high and 13 feet wide of light slats on which are tacked 4 cavalry or 5 infantry silhouettes. The tow-line used is a

3 strand $2\frac{1}{2}''$ tarred hawser 500 fathoms long. According to the English firing regulations practice will be carried on only—

1. When the target is advancing directly toward the battery.
2. When advancing obliquely.
3. When crossing the front.

No practice is allowed when retiring either directly or obliquely on account of risk of ricochet.

A picket and snatch block is used in the advancing target to change the direction of the cable and the team goes off to either flank. If the picket and block is 600 yards in front of the battery the team should be 400 yards to flank at starting, 600 yards being within danger space of common shell bursting in muzzle. The tow line may be run directly through the battery, horses moving to the rear, in which case the target can advance right up to the battery.

From just outside "case" range (400 to 500 yards) to the end of the run, the battery, the pace, should, if practicable, be the gallop.

When moving diagonally (45°) across the line of fire no more than 500 yards of tow line is used and no stakes or blocks are necessary, making the pull direct.

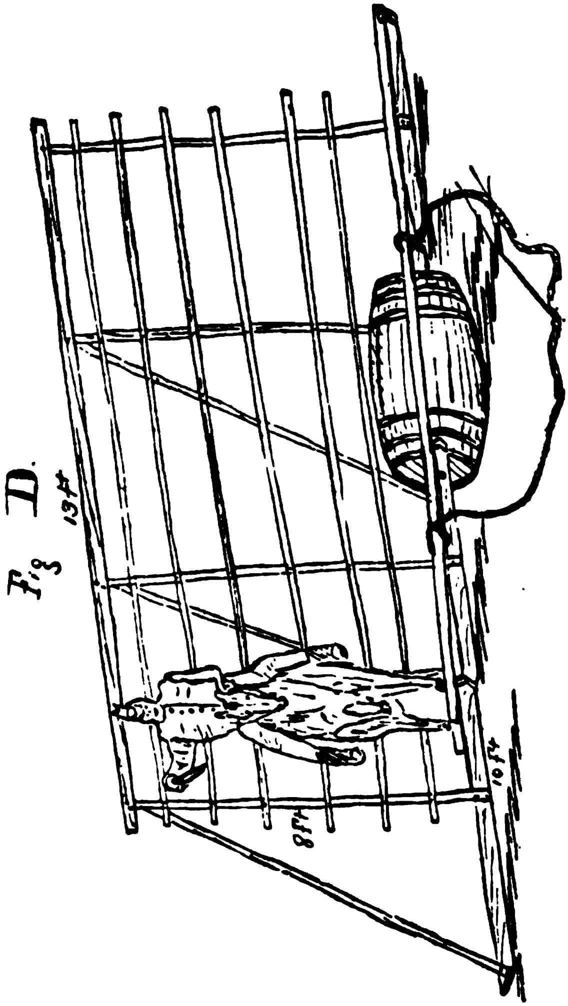
Case 3, moving directly across the front of the battery, is considered the least instructive, the range varying so little; 350 yards of tow line is used between team and this target.

The pace of the moving target may be doubled by hooking in to a single block the standing end being made fast to a picket. (See sketch "D").

Two styles of surprise or disappearing targets are described. "E": On the usual bell crank method, the figures being raised from the prone position to the vertical, by pulling a rope to the flank and falling back again when the pull is released, the friction of the rope being overcome by the sand bag, "A." "F" is a vertical frame of silhouettes on a central post working in a heavy wheel placed horizontally on the ground by means of a rope rigged off to either flank; this may be swung facing the firing point or virtually disappear by being swung back 90° or end on the battery. (See sketches "E" and "F").

Any number of these separate targets can be arranged in a group and operated by one line. (See sketch "G").

In a pamphlet entitled—"Istruzione sul Tiro per L'Artiglieria da campagna, a cavallo, e da Montagna, 1883 (Instruction for Target Firing for Field, Horse and Mountain Artillery), the Italian target used and described is simple and strong and con-



sists of two parallel wooden runners on which screens are mounted representing infantry, cavalry, etc. These screens are hinged at the bottom and lie horizontally when target is at rest, being pulled into the vertical position when a strain is put on the cable. The screen can be placed on the runners at any angle to the line of march of the target and thus be kept normal to the line of fire. The tow line used is rope. (See sketch "H").

In a publication entitled "Instruction for Target Practice, Horse and Field for the German army, 1894," the following targets were described:

The German disappearing targets are many in form but are all constructed on the bell crank and hinge principle, alone or in groups, the silhouettes representing infantry, cavalry and artillery.

The moving targets are all mounted on runners about 3 yards long and 2 to 3 yards apart. The targets are hinged and some of them when the cable is slack represent one thing, and when drawn taut and the target put in motion, another object.

For example—A piece of artillery in action, at rest; and when the cable is drawn taut and target moving, a piece limbered up.

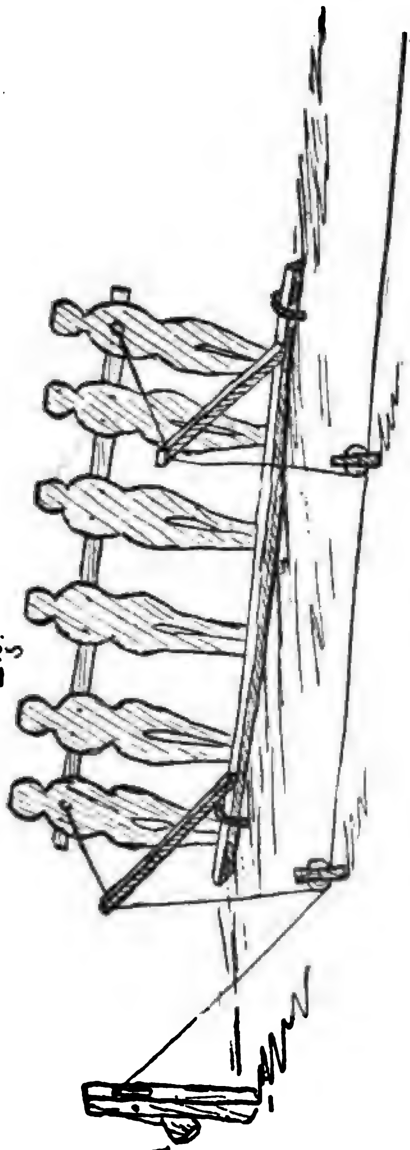


Fig. H

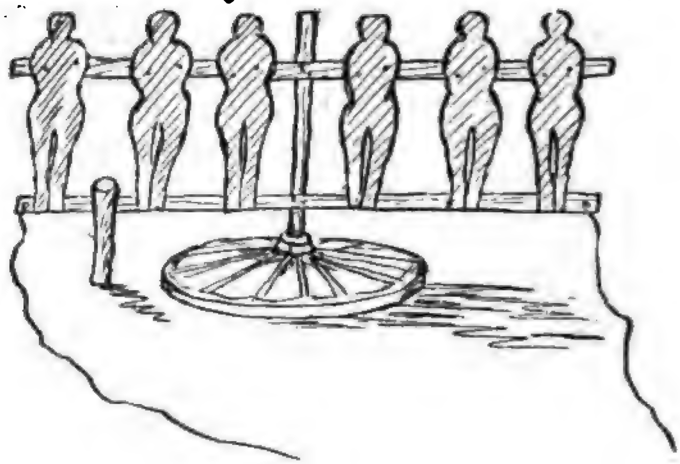
Or—infantry lying down, then infantry standing and moving to the front. (See sketch "J").

The tow line used by the Germans is a wire cable 5 strands for 2 mm. diameter, also a 4 strand steel wire cable 1¼ mm. in diameter, strength 1500 lbs. Two of the forms of disappearing targets, bell crank system, are shown in Figs. "M" and "N"; "N" target being behind a parapet, A

When it is desired that the target stop at a certain definite point, a short piece of rope is put in between the end of the wire and the target, of less strength than the cable; the cable is led between two stout stakes driven into the ground at the desired point, and when the target strikes the stakes, the rope, being weaker, breaks; and the target, of course, stands fast, changing its character or disappearing according to its construction. (See "L"). The cable is carried on reels on a limber body and when broken is spliced after the following method,—the ends are bent back on themselves for an inch or so, lapped about 3 inches by and closely wrapped with third piece of wire, (See Fig. "K") thus making a joint that will easily run through a block.

In a publication entitled "Instruction sur la formation des

Fig. F



pointeurs dans les corps de troupe de L'Artillerie 1888" and in the "*Revue d'Artillerie* June, 1891," French targets and practice are described.

The French assert that the necessity of the employment of moving targets for artillery is universally recognized, but on account of the numerous difficulties they have found in their construction and successful manipulation they state the inventive genius and originality of officers should constantly be exercised to better the apparatus.

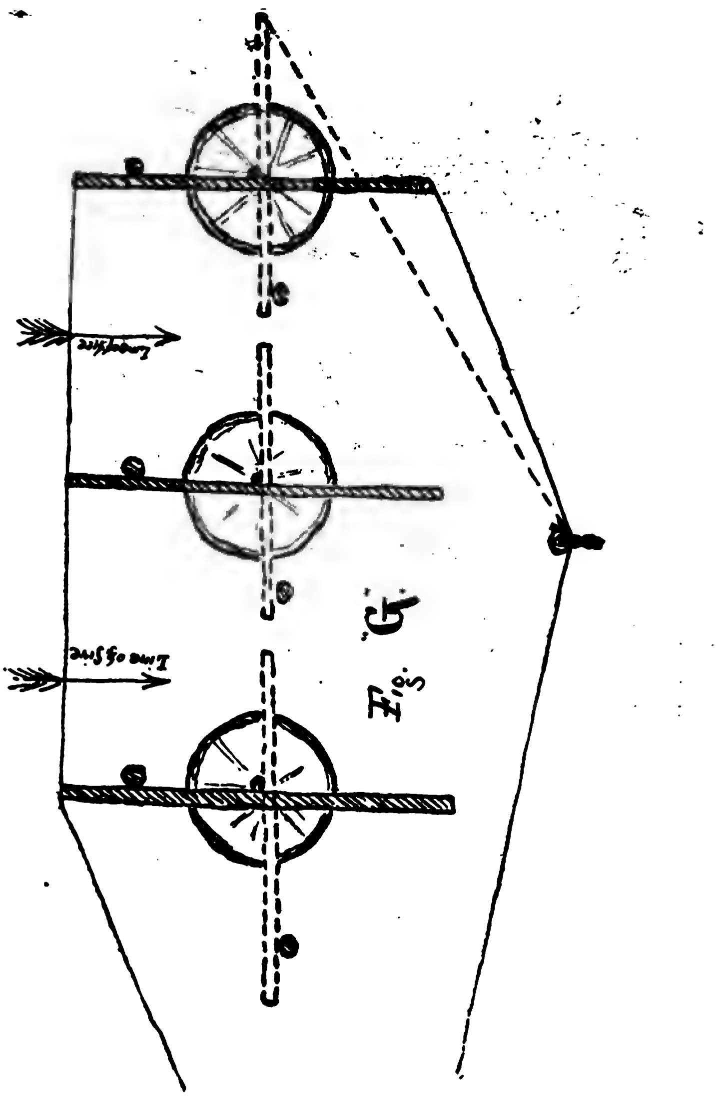
The two greatest difficulties they find are in the breaking of the cable, either by excessive strain or by fragments of shell. The cable used was rope.

Two forms of targets are described, one a moving target and the other a disappearing target.

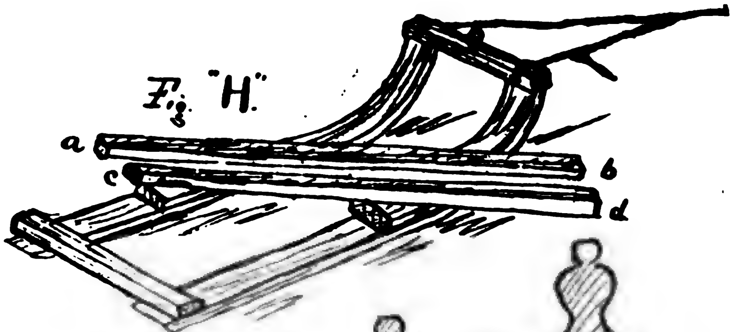
The moving target is constructed as follows: Two limbers with an upright post 8 feet high attached to each with a pulley at the top, are placed 55 yards apart.

Between these posts and suspended from a light wire grill is the target which consists of 25 pieces of cloth 18 inches wide and 4 or 5 feet long suspended from the grill 18 inches apart. The grill is kept taut by a rope fastened to either end and passing through the pulleys at the top of the upright to a heavy iron ball dragging behind each limber on the ground.

To the pole of each limber is attached a separate cable leading parallel to the line of fire, for about 600 yards, or for the distance desired to move the target; then each cable is taken around a



horizontal pulley the same distance apart as the targets (55 yards), the two cables are led off to the same flank and attached together, and the power (steam—4 to 6 horses) is applied leading off about 90° with the direction taken by the target. The disappearing target consists of cloth silhouettes of men and guns suspended f.om a wire grill stretched between two uprights. The target can be raised and lowered by ropes and pulleys, the grill being fastened at each end to a slide working up and down on the uprights. (See sketches "O" and "P").



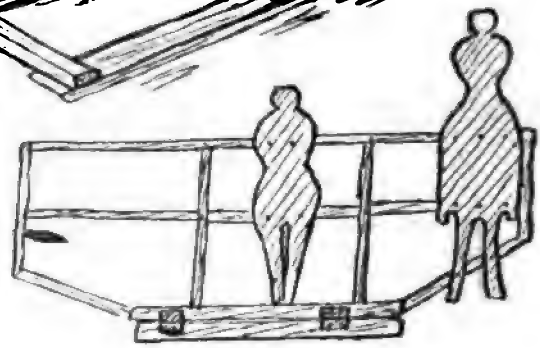
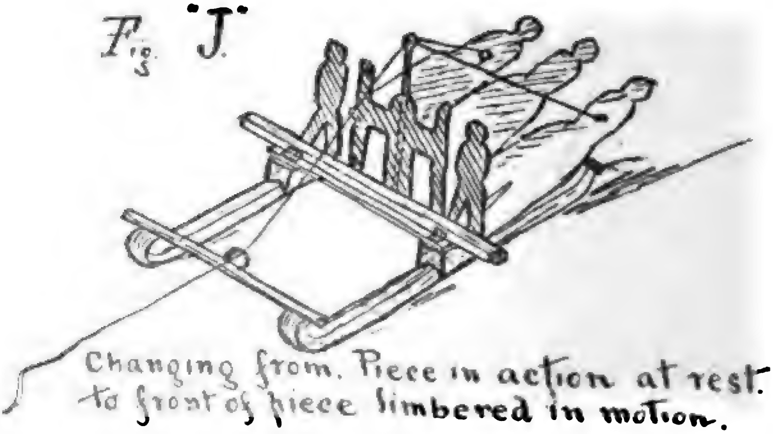


Figure "R" represents an apparatus for gunners practice at a moving target within the post. Two uprights about 20 yards apart hold two parallel horizontal wires along which a small target is arranged to slide. The motion is given to the target by a cord



K

passing over two pulleys, one on each post. One pulley, fitted with a crank has three sizes of wheels of such diameter that the target disc moves at the rate corresponding to a walk, trot, and

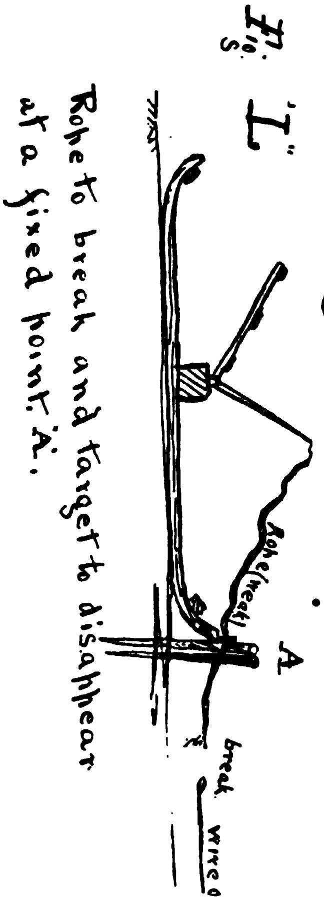


Fig. "L"
Rope to break and target to disappear at a fixed point "A".
Rope (weak)
A
break
wire

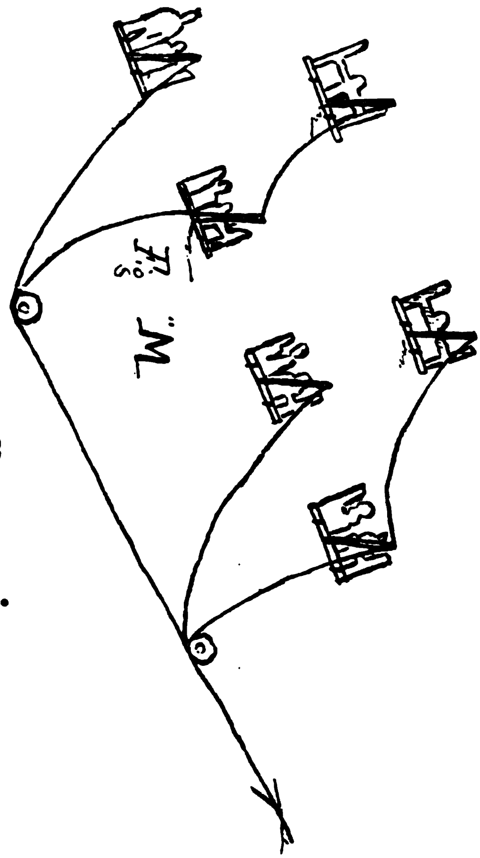
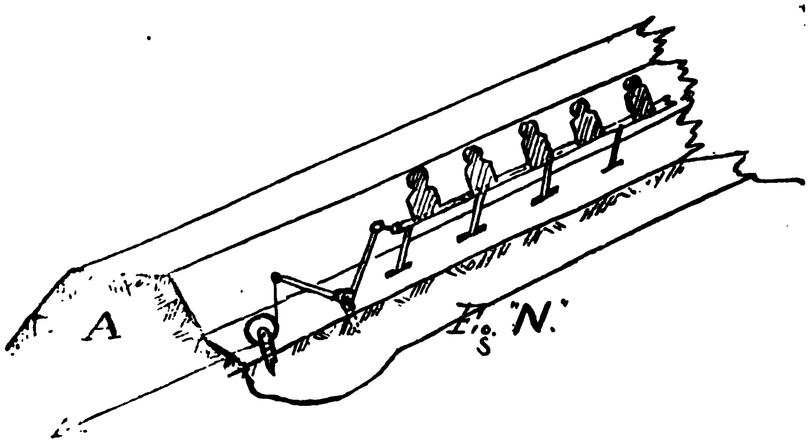


Fig. "M"


A
Fig. "N."

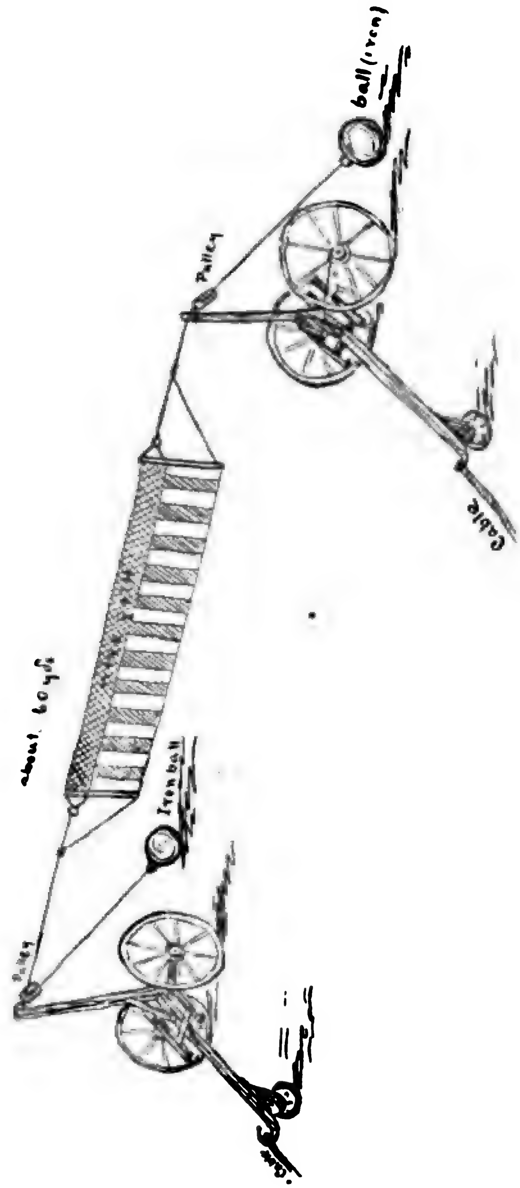


Fig. O.

gallop when the pulley is turned one revolution in one second, the gun being a fixed distance away.

In the instruction laid down the gunners are required to keep the gun constantly on the target by continually moving the trail.

In the practice at moving targets at this post this season (the

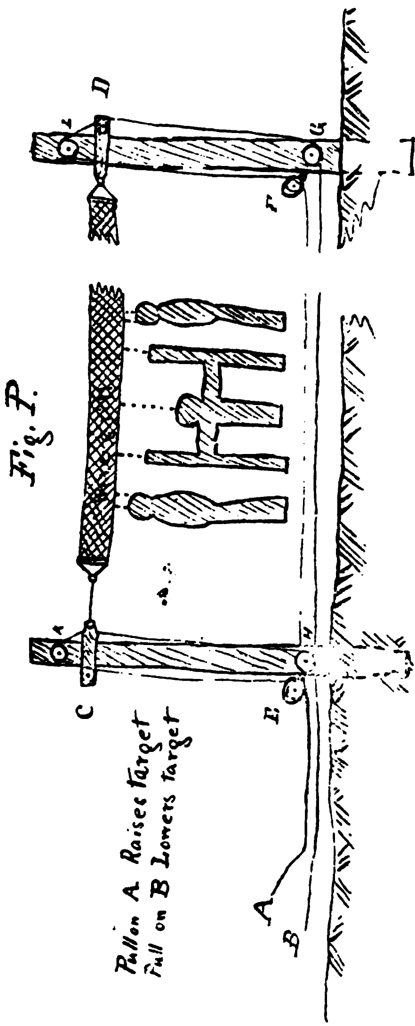


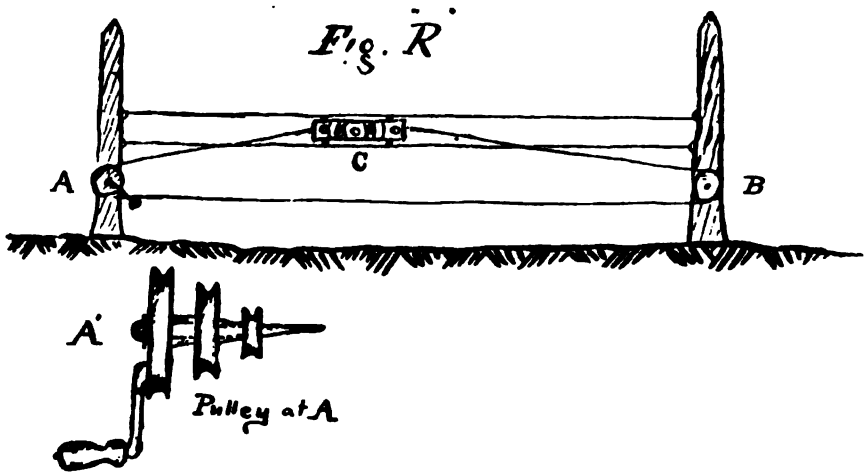
Fig. 1.

first Artillery target practice at moving targets in this countay so far as we have been able to learn) the following forms of targets were used:

First a large roller 16 feet long by 7 feet diameter. It consisted of two board wheels 2 inches thick and 7 feet 6 inches in diameter connected by an axle, and a cylinder of slats about 8 inches less in diameter was formed between the wheels over which was tacked white cloth. The target was put in shafts about 20 feet long the rear ends weighted to form a drag to prevent the roller overrunning the cable when stopping suddenly or going down hill. The pull was made from points C and F in the figure, enough below the front end of the shafts to be in line with the axis H, so as not to tend to lift the rear end of the frame by pulling down on the front end. The suggestion of this target came from Von Schell's tactics of Field Artillery (German). The form of target gave good satisfaction and is one which, I think, with proper cable can be used over the most difficult and uneven ground.

The second form used. Fig. 2, consists of a triangular frame or foundation with a wooden runner in front and a wheel at each rear corner. The target, a light frame 8 feet high by 15 feet long covered with white cloth on which was pasted two mounted figures and three standing infantry figures silhouettes.

The frame was set up vertically on the bed and from front to rear. This form of target worked very satisfactorily, but the wheels and the framed axle became so injured by the few shrapnel fired at it, and wheels being scarce in the quartermaster



transportation bone yard, the form shown in fig. 3 was made, using slides behind and one wheel in front.

This form of target pulls easily but has the defect of having a tendency to run off to one side or the other when the direction of the pull on the cable is not exactly straight ahead, until the wheel gets to that point off the line when the side run is sufficient to slue it back into line. This sluing is disastrous to the wheel and to the lightly constructed frame of the target especially when moving at a gallop. Target No. 4 was then constructed having the same bed construction viz., slides behind a triangular frame and a pair of wheels in front fastened to the target by a king bolt through the front apex. A short iron tongue in front is provided to which the cable is attached. This arrangement readily adjusts itself to the direction of pull of the cable which constantly occurs from the fact that the cable does not remain absolutely in a straight line even if it was straight when starting; inequalities in the ground, brush, weeds and variation of the team from a straight line causes continual variation in the direction of the pull which if at a gallop must be quickly and readily responded to by the target.

The targets on these frames can be arranged with hinges and lever so that they can be made to appear and disappear with the pull and release on the cable and set at any angle with the line of traction of the target. (See Fig. 4).

The cable used during the practice at these targets was a No. 9 galvanized iron wire, costing 3½ cents a pound, about 15 feet to the pound, and as long as twist kinks could be kept out of the wire when laying it down no breaks were encountered. The wire

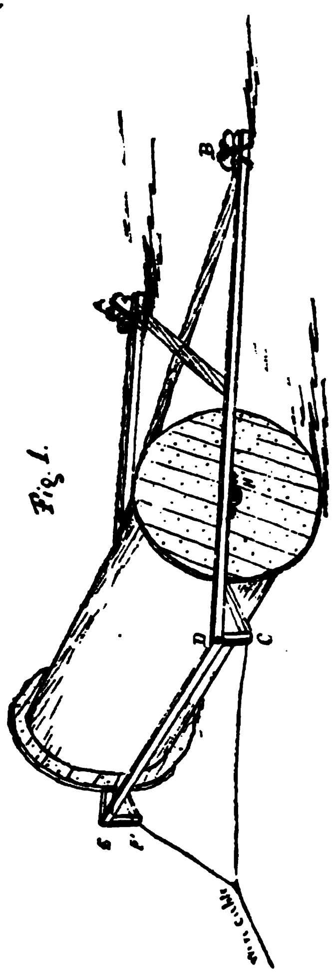


Fig. 1

was laid down and taken up on a wooden reel fixed in a battery cart. In order to provide a pulley for changing direction that would not be of too small a diameter to affect the stiff wire and not increase the pull, two wagon wheels were placed one above the other, an iron bar through the center of both driven into the ground formed the axis, and boards nailed to the corresponding spokes above and below slightly cut out on the outer edge formed the concave surface in which the cable is to run. (See Fig 5).

Considerable correspondence has been had with wholesale hardware dealers and wire manufacturers who have sent on samples of wire cable for inspection but all seems either too stiff or too heavy. The cable described in the German tactics seems to be about the thing and the Ordnance Department has given hopes that the necessary materials may be furnished by them as soon as they are informed exactly what is the best kind.

In his report for 1894 the Chief of Ordnance mentions that a number of forms for moving targets have been submitted but all were so elaborate and costly that they could not be considered. I imagine these targets were exclusively for small arms practice and I do not think this comment will apply to the forms used here.

A little more practice will in time develop the most desirable way to lay a field piece to hit a moving object. If it is moving to or from a battery and is to continue its rate and direction it may be bracketed by two shots and reached by the succeeding ones. Or if it is approaching a point on the ground whose range is known either by measurement or by having previously fired a shot the whole battery can be laid on this point and fired as the target approaches it. This was actually done by the Germans in

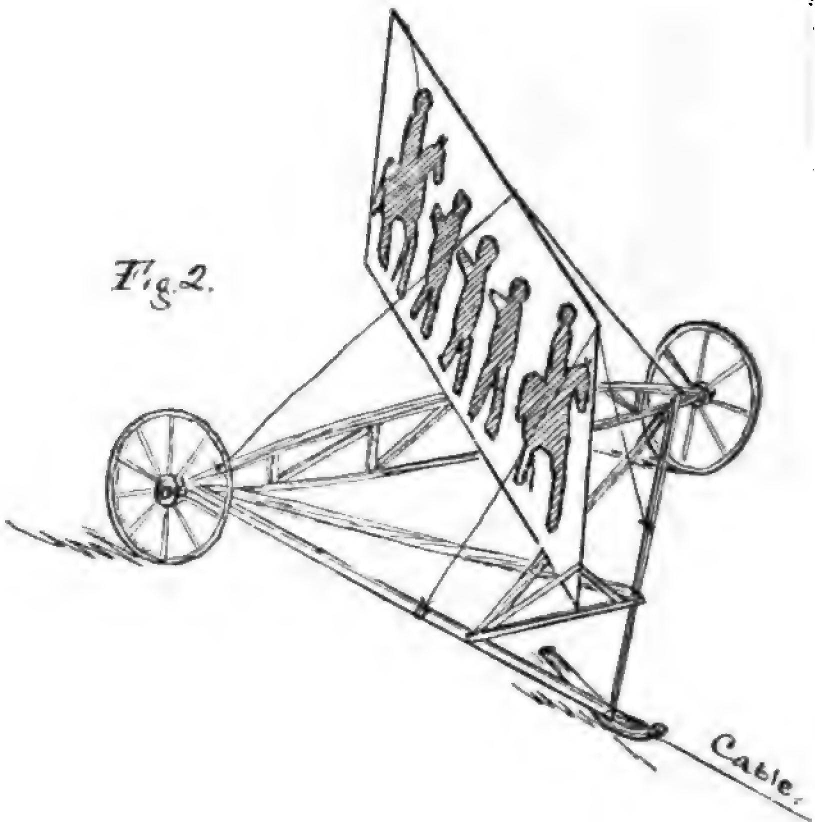


Fig. 2.

the Franco-Prussian war and a whole regiment of French annihilated.

If the target is moving across the front directly or indirectly more necessity exists for the use of the sight right up to the time of discharge. If the range is known and the pieces laid on a fixed object on the ground toward which the target is approaching, the gunner must estimate the proper distance of the target from the line of fire to allow for the movement of the target during the time of flight of the projectile.

This system involves the finding of prominent objects toward which the target is approaching, and also the uncertainty that the gunners make no error and all train on the same object in case it is desired to fire a volley.

From an examination of the range table of our field gun, taking into account the time of flight and the departure of the projectile from the line of sight, at the different ranges, for a point on the rear sight, and applying the distance passed over by the target,

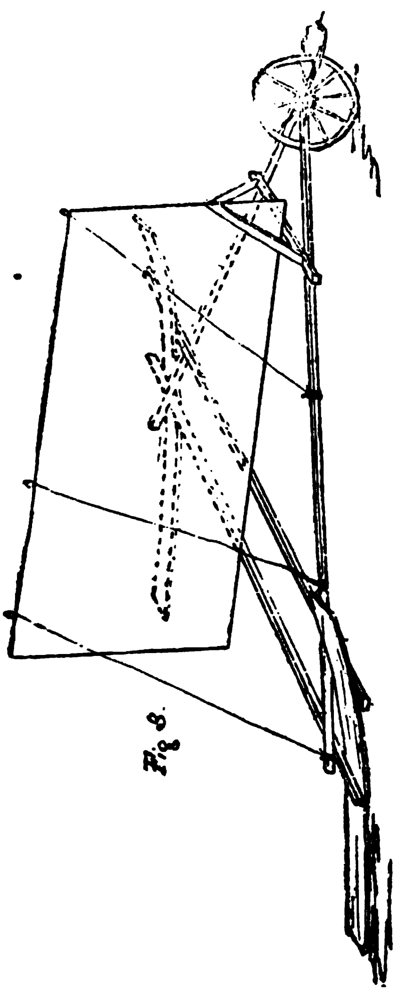


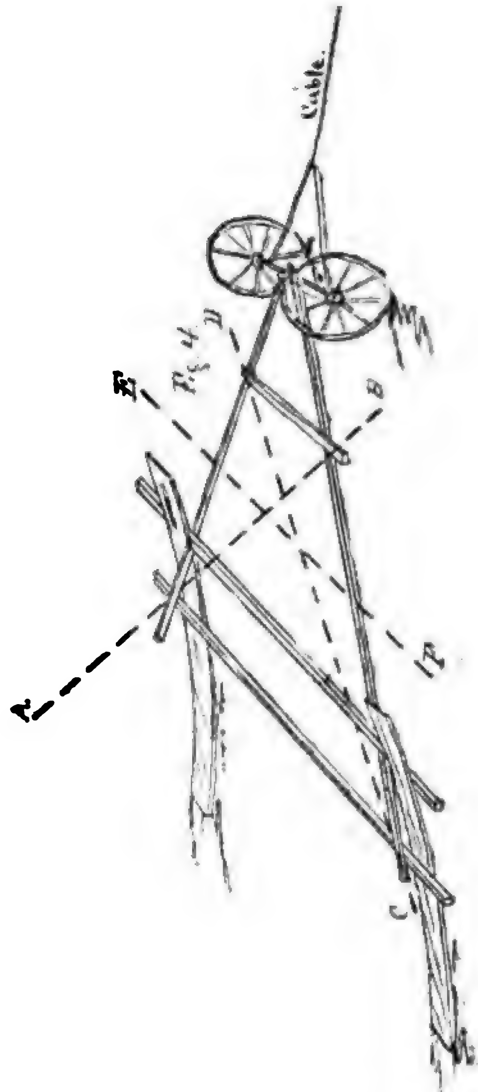
Fig. 8

6 feet per second for a walk, 12 feet per second for a trot, and 18 feet per second for a gallop (the tactical gaits) it is seen that the happy relation exist between the time of flight of the projectile and the change of position of the target at the same range, that by allowing two points, four points, and six points, for the walk, trot and gallop respectively, the projectile and target will meet no matter how far from the gun. The error in any case does not exceed the length of a horse. This was demonstrated in a paper by Lieutenant Ridgway, 5th Artillery, on Light Artillery Target Practice read the past week. Taking advantage of these conditions and believing that a sight that could remain in the piece during discharge and be of such character that the gunner standing a safe distance in rear could accurately determine when the target crossed the line of sight and discharge the piece, the following arrangement is suggested: On the top of the piece, fitting into the socket B, a horizontal bar, F G, moves right or left by a thumb screw E, and allowance can be made for wind and drift K; a thin steel upright moves right and left to points, as L, M, N, for target going at walk, trot, or gallop, from right to left. Notches 200 to 500 yards apart on upright could hold a sliding bead S, P or O, and give means of obtaining elevation; a level which would withstand shock of discharge could be attached to the horizontal bar.

Results of Practice at the Moving Targets. Season, 1897. Fort Riley, Kansas.

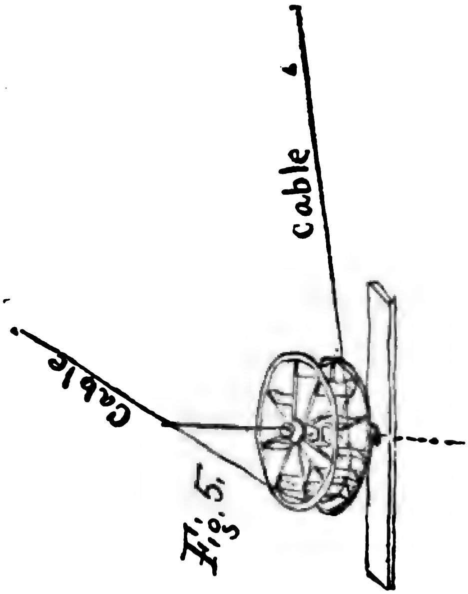
Light Battery B, Fourth Artillery.

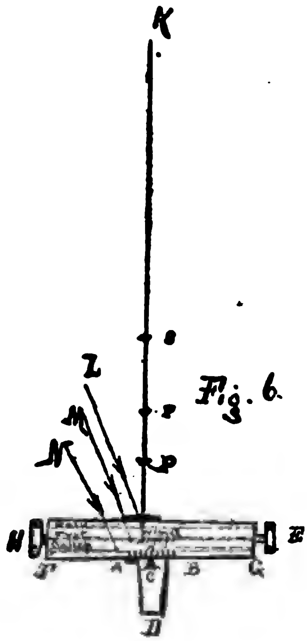
Four (4) shrapnel were fired at target No. 2 (rectangle 15 feet



long by 8 feet high) moving at right angle to line of fire at a trot. Range (estimated) 1200 yards. Fuze was cut at $2\frac{3}{8}$ seconds and an allowance of $2\frac{1}{2}$ points left was given. Eighty-four hits were made all bursting in front except the last which burst at the target demolishing the upper right hand corner of the frame. The rear wheels of target were badly damaged.

Two series of 4 shots each (shrapnel), eight in all. were then fired at target No. 2 moving at a gallop at an angle of 65° with





line of fire, range varying from 1200 to 1100 yards, fuze cut from $2\frac{3}{8}$ to $2\frac{1}{8}$ seconds, an estimated allowance of 4 points was given. Thirty-eight (38) hits were made.

Target No. 3 was then attached directly in rear of target No. 2 and the two moved at a gallop at right angles to line of fire. Two shots were fired, estimated range 1200, fuze $2\frac{2}{8}$, allowance (estimated) $4\frac{1}{2}$ points. One (1) hit was made.

Target No. 1 (canvas cylinder) was then moved at a gallop approaching the battery in a direction about 25° to line of fire, starting at an estimated range of 1600 yards and finishing at about 1200 yards from battery. The fuzes were cut from $3\frac{2}{8}$ to $2\frac{3}{8}$ seconds. Forty-eight hits were made. No allowance.

Light Battery F, Fourth Artillery.

Target No. 4 rectangular frame 15′ by 8′, was moved at a gallop at about 80° with line of fire, at an estimated range of 1600 yards, seven shots (shrapnel) were fired, first three to burst on impact, next three cut $3\frac{1}{8}$, 3, and 3 seconds, last one impact, allowance 5 points left: five hits were made.

The same target was then moved at a trot across line of fire at about 70° from left to right at estimated range of 1350 yards receding from battery. Allowance 1 point right, elevation 1300

yards, cut to burst on impact, the target then moved back over nearly the same route, four (4) shrapnel being fired in each series. In the second series the fuze was cut at 2⅝ seconds. Eleven hits were made.

Target No. 1, canvas cylinder, was then moved from absolute cover at an 8 mile trot from right to left at 85° with line of fire, estimated distance 1400 yards, presenting little more than the end (circle 7½ feet in diameter). Six (6) shrapnel were fired, allowance 1 point right, fuze cut to burst on impact, sixteen hits were made. The last shot bursting in or so near the target that it was completely disabled, the exposed shaft and front cross piece being demolished.

This battery was entirely in ignorance of the original position of this target or its probable direction of movement.

Several methods to make the proper allowance for movement of the target during the time of flight of the projectile were employed, from estimated "hold off" used in wing shooting to giving such an allowance as would enable the gunner to lay on the target, remove his sight, get clear of the wheel and command "fire," this interval added to time of flight of projectile to the target being equal to the interval of time consumed by the target in passing from its position when aimed at, to its position when the projectile reached it. Having no sight that could be left in the seat while the gun was fired these methods were resorted to. It all furnished excellent practice and instruction and the results were considered very satisfactory. Another season the battalion commander hoped to develope the practice in a thoroughly systematic manner.

The officers in command of the batteries firing were authorized to regulate the amount of the practice and the conditions and movement of the targets.

First Lieutenant C. G. Treat, Fifth Artillery,
Adjutant, Light Artillery Battalion,
Fort Riley, Kansas.

THE KRUPP 7.5 CM. RAPID FIRE GUN IN THE CUBAN CAMPAIGN.

By ATANASIO TORRES, Captain of Artillery in the Spanish Army.

Memorial de Artilleria.

Scarcely had the insurrection in Cuba begun with the alarm of rebellion in Bayre, when the authorities concluded that in order to obtain the mastery over it, they must reduce the enemy by superior power, due not to numbers alone, but also to the courage, morale and drill of the troops, and especially, to the continued possession of efficient weapons: a cardinal factor in the military power of a nation.

As to the item last mentioned, the evidences of progress in that direction have of late been such that the Small Arms Committee has, only after exhaustive experiments and conscientious investigation of the matter, decided to adopt the Mauser Rifle for our infantry; and even then they have decided to make important modifications in it, that enable it to be called the best small-arm extant.

With a standard fixed by law, and made a part of the regulations on December 7, 1893, it was evident that the necessity was urgent for a change of armament of the infantry: that it should be given an arm of reduced calibre, which, on account of its perfect construction and adjustment (due to industrial and mechanical improvements) secures, by its adoption, all the inherent advantages of modern powders, which, with low pressures and without injury to the piece, give high velocities and, consequently, increased accuracy, greatly extended danger zones and far greater ranges (up to 4000 metres); in addition, it is a repeating arm, delivering many projectiles in a short time.

With so terrible a weapon in the hands of a soldier inured to hunger, thirst and fatigue, who is cheerful and not afraid to die, who is guided only by a sense of duty, who is as brave in war as he is noble and kind in peace, our infantry is able to meet any regular foreign army whatsoever.

Mountain artillery has already been used: by its effect was seen the importance of this arm and the part that it was to play in the present campaign.

The disadvantages that would follow the use of the Plasencia

gun in the struggle, did not escape the foresight of the War Minister, since that piece, though it had been a good one and had given excellent results in its day, could not compete with modern guns, either in power, precision, or rapidity of fire, although great range is not an element of importance in mountain warfare. The contingencies of the future had to be foreseen, and the same reasons which led to the change in infantry arms, could be urged with reference to the artillery *materiel.* It was necessary to secure the equilibrium of the two arms, and to harmonize them.

As a solution of this question the rapid-firing gun presented itself, since an increase in rapidity of fire is one of the desiderata; yet energy is a greater requisite than rapidity. These two are difficult to combine, because the increase of mass of the projectile to produce energy, decreases, by the difficulty in handling ammunition, the rapidity of fire.

In the 7.5 cm. Krupp gun are combined power, rapidity of fire, precision and range; and to meet the requirements, the pieces rendered necessary by the exigencies of the campaign were purchased from the reliable firm mentioned, and sent directly to Havana.

The Committee on Experiments, with due promptness, set forth their ideas as to the merits of the new ordnance, in a report which was, as usual, clear and concise. As to the deportment of the piece when firing, the Committee could not have reported more favorably; but as to its transportation they were unable to give a positive opinion, for want of means of experimenting with it.

Although the parts fitted the packsaddles well enough, the saddles themselves left much to be desired; for, besides minor details, the skirts were too small, and the saddle too short, so that there was scarcely sufficient contact with the animal to ensure the stability of the load. The general arrangement of the whole, besides requiring supplementary equipments in each case, was very defective in itself, leaving all the packs very high and unstable. The defects were of such magnitude, that, from the beginning it was plain, that no amount of effort could overcome defects that could not possibly be corrected in a short time, since an almost radical change was necessary. On the other hand the circumstances did not justify the abandonment of tried, though old methods for new ones, with no certainty as to the result. The insurrection, then at its climax, demanded rapid organization, which led to the conservative use of the pieces in permanent garrisons, or in defensive batteries on the line of works between

Mariel and Majana, in order that, in the meanwhile, the Maestranza* might make a modification of the saddle or project a new one, which would have the qualities necessary for the transportation of the new *materiel.*

There was still reserved for the Plasencia piece a glorious future. Its record was so brilliant that it was not to be immediately supplanted, but was (perhaps in anticipation of its abandonment) to give additional examples of its prowess. It has many friends and advocates of every class, who know its value and its short comings; and, knowing them, feel for it the regard due its record of former service and merit.

Moreover, it served in the present campaign with commanders worthy of mention: it has triumphantly overrun the whole island under the command of the successful Captain Carles; it was necessary to play a bold and intrepid part in dealing with Jiménez Andino, in Coliseo, with Vilarragut in Galope, and with Lirón in Paso Real; to be steady and composed with Isasi, delivering its fire in high pitched notes, in a bloody collision between two once friendly armies. To it no obstacle seemed insurmountable; it climbed the hills with the same ease with which it descended into ravines, "went everywhere," according to the characteristic expression of Lieutenant Sebastian; it was the support and mainstay of the column, before the trenches of the enemy, with Lieutenant Tomé in the eastern province of Bayamo; it thoroughly proved its efficiency in the attack of villages with Saenz de Cenzano, protected with its fire, under the orders of Miñon, the well-known retreat of the battalion of Alfonso XIII, from the camp at Lechuza (a place near Curzo) to the seashore, where were four hundred men hard pressed by the incendiary legions of the insurgent chief Maceo, and performed, for six hours, prodigious feats of valor. No one opposed the idea of continuing to utilize its services, pending the solution by the Maestranza of the problem proposed to them; and, as if proud of having confided anew to it the honor of the corps, we see it bear with patience the brunt of the battle in Ceja del Negro, with Quintana and Casal, and show itself heroic in Cacarajicara with Arboledas; and, everywhere, it nobly aspires to glory, its shortcomings being atoned for by the bravery and skill of its officers.

After a careful investigation by the capable officers composing the Maestranza, particularly by Captain Riestra and the capable Campa, and in spite of difficulties of no small magnitude, which delayed their construction, there appeared two models of pack-

Meastranza: a board of officers.

saddle, which differed from each other only in the length of the skirts and in some minor details. In these saddles nothing was retained of the Krupp model except the frame. The cover was that used on the island for the Plasencia *materiel*; the framework was of forged steel and was strong enough for any load; the wheels were suspended from hooks; the old form of bed had been replaced by small iron plates, and the weight of the whole saddle including the harness, which, in the breaststrap alone, underwent any change, was 41 kilograms.

Thus I have briefly shown the difficulties which from the start interfered with the proper equipment of the batteries of the Krupp Guns. These guns deserve, henceforth, most careful attention on the part of the authorities; and in view of the satisfactory results, when the difficulties had been overcome, I will enter fully into the discussion of my subject, and set forth the ideas suggested to me by its use in the present campaign.

In the latter part of October (1896) the Sub-Inspector General conferred on me the unmerited honor of placing in my hands the organization and command of a mountain battery of 7.5 cm. rapid fire Krupp guns, which was to be part of a mixed brigade of artillery of recent organization. There was assigned to it the following *personnel*: 5 sergeants, 16 corporals, 2 trumpeters, 16 first class, and 111 second class privates, a blacksmith and an assistant blacksmith: 152 men, all told. All these, except the artificers and non-commissioned officers (who had, almost without exception, to be appointed) came from the new arrivals, sent from the Peninsula to fill up vacancies, and had come mainly from regiments of mountain artillery. The animals for transportation were 60 mules, 4 officers' horses, and 5 spare horses. The battery was to take four guns, with a complement of five mule-loads of ammunition per gun, giving a total for the battery of 240 projectiles, of different kinds, classified as follows: 120 shrapnel, 80 shell and 40 canister. For the service of security, there were assigned to the battery 25 Mauser Argentine carbines with proper ammunition. There were sent to us for trial two models of pack-saddle planned by the Maestranza: a single model was promptly selected; since, of the two, the one with longer skirts proved, on trial, to be the better saddle.

I do not propose to enter into the minutiae of that which is common to all newly created organizations, but I consider it pertinent to give certain facts which indicate the aptitude shown by the men in handling the materièl.

The pieces were received by the battery and drill began in the

latter half of October. The animals began to be received about the last of the month and were all there by the tenth of November. Almost at the same time the pieces began to come back from the Arsenal, whither they had been sent for slight alterations,* and instruction began in loading and unloading the packs, drilling the gunners and artificers and the battery. To this was devoted the remainder of the month. The first and last official act at which all the battery was present, was the formation that took place on the day of the Holy Patroness, while mass was being celebrated. That is to say, that after a little more than a month being devoted to organization and instruction, it must be borne in mind, in order to justly appreciate the condition for service of the new material, that all the elements, personnel, animals, materiel, pack-saddles and drill were being tried for the first time.

One hour had elapsed after the battery returned from the formation when I received the order to get ready to put the first platoon† on the train and take it by rail to Santiago de las Vegas. At dawn the following day began its first march on the road with the battalion of light infantry from Las Navas, joining in Bejucal the column of General Figueroa, to which it remained attached in order to operate in the province of Havana, continuing the march as far as Quivicán, which we reached at 4 p. m., spending the night at this point. At 6 a. m. on the 7th we left that town, joining in the village of Aguacate the forces of Colonel Tort and the whole column took the direction of the Heights of Seibado and Rio Hondo, where it was supposed that the enemy would be found. It was 11 a. m., the column were making efforts to approach under cover before attempting the ascent of the hills, when the first shots of the enemy's advanced line were heard. Immediately orders to advance were given. The country offered much inconvenience on account of the brambles and briars and stones. It was not long before it was seen that the enemy in considerable force, crowned the heights of Morales; the artillery, placed in a clear space in the road delivered four rounds and, their position having been abandoned by the enemy and occupied by our troops, it was necessary to find new positions in order to dislodge them, in succession, from the heights of Volcan, Babiney, Platano (where the Lieutenant-Colonel of the light in-

* These were practically the addition of braces on the lower part of the trunnion beds to prevent the lateral play of the carriage, and the addition of an opening in the rear part of the carriage, for receiving a handspike to assist in the operation of loading.

† The second platoon left four days later and was attached to the army of General Hernandez Ferrer. This platoon found a permanent station in Havana, making frequent rallis into the province under Lieutenant Franco.

fantry found a glorious death) and Nazareno, whence we retired at 5 p. m. (not without leaving many dead, and taking with us a number of wounded) marching in column (the night having already come on) towards Campinge and Linea Plata, reaching at 9 o'clock the Santa Amelia sugar farm.

This march was one of the most difficult ones made by the platoon, because, neither the men nor the animals were accustomed to fatigue or privation and here they had to endure hardship, without eating or drinking at any time during the day, having to load and unload the material a number of times in changing position in order to cause a change in the enemy's lines. In order to do this, the guns had to be moved and fired with all the rapidity possible under the circumstances, the way being frequently over broken and difficult ground. Finally, the difficulty and monotony of night marches, aggravated by such accidents as mules falling down etc., completed a long day of trials; and fortunately our commanding general expressed only entire approval of our work.

The battery continued its work among the hills included in the quadrilateral formed by Managua, San Jose de los Lagas, San Félipe and Bejucal, making, usually, marches of eight or nine hours with loaded material. This lasted until the 20th, when it was sent to Manzanillo, to join the brigade of General Hernandez Ferrer, forming a part of the division under General Bosch, which devision was intended principally for the protection of convoys from Manzanillo to Bayamo and other points in that jurisdiction, such as Giguani, Guira and Cauto.

A detailed and exact description of the disposition of the forces, has no place in this article; nor have the order of battle, or the various accidents of the ground in the different engagements in which the platoon took part; but it seems pertiment to say that conducting convoys is one of the most difficult of military operations. The attitude of the escort, being essentially defensive, requires that the desire to attack be restrained and that all efforts be directed to the main object of the escort: which is simply to force a way for the convoy, when it is necessary to do so. To this end there must be a strong advanced guard to discover and repel ambuscades and surprises, and to capture and occupy important positions; and this guard should be always composed in part of artillery. The principal danger to a convoy is on its flanks, which necessitates the detail of numerous forces for reconnoissances, in order to obtain a thorough knowledge of the roads and cross-roads. The fights in which the vanguard

engages are nearly always bloody, since the enemy compels it to adapt itself to surrounding conditions, as at the ford of a river, on the other side of which is a position strengthened by trenches, or when the road is obstructed by fallen trees or other obstacles that compel the detention of the convoy under fire, the enemy being perhaps under cover of the bushes and thickets, where he finds such safe refuge, knowing his bearings. Under such circumstances, marauders and adventurers find themselves at an advantage, while regular troops suffer, since, in fighting in the brush, they are much exposed, and adequate control and command of the individual is rendered impossible.

This explains why the enemy's forces, relatively protected, can prove to be a serious obstacle to the march of a convoy.

In obedience to these general principles, the two platoons, one belonging to each brigade, marched always in the advanced guard. The platoon of Plasencia guns, commanded, with intelligence and decision by Lieutenant Tomé, shared with mine the fluctuations of fortune.

On the 8th of January, in the "Cienaga de Jacaibama," after the removal of an obstruction of trees extending over more than 200 metres, the platoon protected with its fire the rear guard of the convoy, which was attacked when the road was being opened for the passage of the wagons. We fired over the heads of our own troops, sparing our two lines of fire, and taking as a target the smoke made by the guns of the enemy, which was perfectly visible, because they used the Remington arm. On the 26th of the same month in "Sabana Barranca," the two platoons protected with their fire the advance of our infantry, which charged the enemy and drove them a considerable distance into the forest. On February 1st, in "Potrerito de la Villega," and on the 5th in "Babatuaba," their shrapnel fire utterly routed the insurgent hordes. On March 3rd, in the valley of the river Buey near the "Caimito," the enemy held a commanding position, strongly intrenched, with the river in front and an absolutely safe line of retreat, and it was necessary to demolish their works with the fire of the four pieces, compelling them to abondon their position, though the column suffered some loss. Finally, in the valley of the river Cautillo, while assisting in the protection of the village of Giguani, which was besieged by the insurgents, the platoon protected with its fire a flanking battalion that met with resistance.

Along the roads, the pieces were generally *drawn*, except on

difficult portions of the road, such as rivers, and broken country; or on rainy days, when the mud did not permit it, or on considerable stretches of road that were naturally muddy.

The platoon remained for the purpose of protecting convoys and of taking part in some operations in the neighborhood of Bayre and Cauto, until March 26th, when it marched to Ciego de Avila, in the military division of Júcaro á Morón, where it remained as light artillery of the line, until May 1st, when it was provisionally attached to the brigade of General Ruiz, with which brigade it was constantly engaged in military operations, until the 17th of the same month, when it returned to Ciego de Avila. In this expedition the platoon took part on May 3rd, in the fight at the "Reforma" ranch, which resulted in the occupation of the enemy's camp situated on the other side of the river of the same name. In "Pelayo," "Trilladeras" and for the second time at the "Reforma" ranch, it effectively intervened, now defeating the hostile cavalry at long range, now assisting to dislodge them from camps and commanding positions, taking tactical positions, according to the surroundings, and always governed by the directions of the indefatigable General, who with men and animals on half rations, kept in constant motion the army of the insurgent leader, Maximo Gomez.

In the latter part of that month, in consideration of the satisfactory result of the campaign, the general-in-chief ordered the dissolution of the mixed brigade, giving me a verbal order at Ciego de Avila to take the platoon back to Havana.

After this brief sketch, it is proper that I should give my impressions,* it being understood that they pretend to only a relative value, in view of the kind of wartare. The numbers and character of the enemy, his system of armament, the character of the terrain. and especial tactics of the engagements, characterized by the absence of artillery among the enemy, make it evident that the platoon has not played a part so important as that which it would have played, had its appearance been justified as a necessity of modern warfare.

The piece being known to all the readers of the "Memorial" by the description given of it by General Carrasco in June, 1896, I need not praise its excellent qualities.

The use of the metallic cartridge does away with the inconveniences of obturation giving a fermeture of rapid and easy manipulation, composed of durable parts. These parts can be

* These with slight variations are extracted from the report directed by me to the government in June last.

easily taken apart; and the striker, spring and needle replaced in a short time; the cartridge is withdrawn by the extractor with absolute certainty; and there is an arrangement for eliminating recoil and one for making slight changes in pointing. This piece has a range of upwards of 3500 metres with corresponding accuracy of fire, delivering a projectile of 6 kilograms weight, with considerably increased velocity. All these attributes make the piece an element of terrible power.

But it would not meet the requirements of mountain warfare, had it not moreover, to the fullest extent the mobility necessary to accompany an army to the theatre of operations. Therefore, it must be discussed from three points of view: its service qualities; its fitness for transportation; its behavior under fire. It is a tactical principle, and the foundation of all instruction that the battery should be able to pass rapidly from any formation to that in battery and *vice versa*; and with the same promptness to use the pieces with the object of gaining the advantage from the start. Hence, first of all, the artillery *materiel* should be capable of being promptly and easily packed and unpacked; next, that it should have certainty of action and a simplicity of mechanism, adapted to the intelligence of the cannoneers, and that inaccuracies of fire should be promptly corrected.

From the first of the three points of view, it must be borne in mind that it takes six operations to pack, and as many to unpack, these being necessitated by the dismounting of the gun carriage, loading separately the wheels and the piece composed of the trail and axle; but such work is simple, and exacts only thorough instruction of the *personnel*, and methodical and exact drill, making each man take his turn at it, so that he will convince himself that what appears complex work at first sight, takes when compared with its analogue in the Plasencia system, a very short time, such as is perfectly allowable for unpacking the piece.

As to the convenience of separating the axle from the trail, the consideration of the reduction of time in unloading diminishes the ultimate amount of time; so that it is a matter of indifference, as regards time, which system is employed.

The service of the piece in firing could not be more expeditious nor less difficult for those who have to manipulate it.

The instruction of gunners and artificers, and particularly the artillerymen of the second class, ought to be as full and as thorough as is possible under the circumstances, since on *them*, first of all, evidently depends the efficiency of fire of the piece; and they can thus relieve the captain of certain details and minor

duties, permitting him to follow quietly the vicissitudes and changes of fortune of the fight.

Fuse cutting, after a little practice, is performed by the artificers with relative ease, as is, also, dismounting and assembling the parts of the piece; nor does the manual of the piece give any difficulty.

With ten men and a chief of piece for its service all the positions are completely filled, without undue fatigue to the men concerned, in spite of the idea that a greater number might be used with the object of shortening the time of work, or increasing the convenience; a result which is imaginary, as the men get in one another's way and hinder movement. Good effect is obtained not by numbers, but by giving to each man an opportunity to discharge his particular function. Moreover it would not be prudent to use less than that number; for, frequently, a smaller number only is available, as happened to us on more than one occasion, when it had to be done with eight men, notwithstanding the fact that we began operations with five supernumeraries.

The above method of instruction may be used, or else that laid down in the manual of the old piece, varying, as occasion requires, the interval between the pieces in the formations in line and double column, observing that each piece has an extra load.

As regards mobility it is known that the ordinary means of transportation of mountain artillery is on the backs of mules, using the shafts, however, for drawing it along suitable roads. There must, then, be considered the conditions of (*a*) the load, and (*b*) the traction of the *materiel.*

Comparing the weights of the loads as I distributed them, with their analogues in the Plasencia system, and allowing the same weight for the pack-saddle, it is found that the load of the carriage and that of the wheels weigh more in the Krupp than in the Plasencia system; the other corresponding loads are lighter, particularly the ammunition loads in which the difference in favor of the Krupp gun exceeds 20 kilograms. In the load of wheels the excess is only 5 kilograms, and, in the carriage load, in which, as above stated, the Krupp system is at a disadvantage, the weight is, notwithstanding, included between 160 and 170 kilograms, which is generally accepted as an ordinary load for a mule, as it does not exceed 180 kilograms which, as a maximum load, can be easily carried, including the weight of the shafts.

The principal inconvenience of the carriage load (besides its weight) is the height of the load, which exposes it to continuous

vibration, and to unbalancing. It is considered preferable to raise the carriage to the mule from the wheels, leaving the axle-tree on the carriage, as this slight increase of weight is more than compensated for by the stability that this gives to the load; an increase of weight of 3 or 4 kilograms amounts to little, while nothing is more trying to the animal than an ill-distributed load.

As regards traction, more effort is required on the part of the mule, than in the Plasencia piece because of its greater weight. The height of the muzzle above the ground being considerably less than in the old system, it is more difficult to draw in marching along roads slightly rough; but this same characteristic and the strength of the wheels give it more stability and better conditions of draught along good roads and highways.

The disadvantage of weight is increased by the poor arrangement for draught, which makes the carriage move irregularly instead of at right angles to the axle making it necessary for the shafts to readjust their direction and that of the carriage. It is desirable not only to correct the defect mentioned but also to avoid premature destruction of the connecting bar, due to throwing all the strain on the bar (connecting the shaft with the trail), which causes the brass collar that holds the bar in place to move laterally; and the destruction of the wood due to the excessive play of the bar in its collar causes the point of junction to lower until it reaches the shafts touching the animal, and making it impossible to use them.

The adoption of two rings with a sufficient length of chain (for purposes of traction) extending from hooks on the axle to the point of attachment of the single-tree reduces very much the work of the mule in drawing it, and eases his movements by permitting a slightly better adjustment of the breast leather; and, furthermore, two mules can be conveniently harnessed to it, as is sometimes done.

As we have seen, the piece cannot be considered heavy, if we regard its elements in detail; nor is the divisibility of the carriage a defect, if we consider the ballistic qualities which it possesses; but certainly in my humble opinion, the projectile should be reduced in weight to 5 kilograms, as it would then have still the power necessary for its purpose, and the ultimate weight would thus be reduced, increasing the ease of transportation and partly solving the question of ammunition, which is the only objection that can be imputed to the system, because it involves an excessive number of loads per battery, requiring too many animals and adding nothing to the simplicity of the old batteries.

Except in the respects indicated, the present piece is transported perfectly over all kinds of ground, stands the marches well, and can be placed in battery in a short time.

The pack saddles have already been discussed at some length. But, without begrudging them their merits (which I am glad to recognize, as they helped to solve an extremely difficult problem), I must say that they have not entirely justified the enthusiam that I felt when they were first tried. The adaptability of the trail and trunnion beds to the process of loading is, I believe, well understood. The surface of the saddle is not so satisfactory, since, instead of keeping the trail in place, where it conforms to the animal, the saddle allows the trunnion beds to slips too far forward. This may be due to a springy effect arising from the elasticity of the little plates of iron ; at any rate the result is that, after a short time of use (during which the load fits the bed) the saddle is deformed.

On the question of padding, opinion is divided ; there are those who prefer wool as more elastic and making the saddle more comfortable for the animal, by fitting better ; while those who advocate goat's hair allege that, in its turn, it is cooler for this climate and more easily obtained ; that a good fit with this material is obtainable under favorable conditions with skilled workmen. Nothing less than actual experiment with both systems can rationally determine which is to be accepted ; although I am inclined to believe that I would immediately decide in favor of the former.

Perhaps the effects produced by the shortness of the saddle, have been exaggerated ; for in view of the discussions of the new loads the shortness means diminution of weight, which may be considered as a compensation. For when we compare the new loads with the old, we find that the carriage is the only load in the Krupp system that weighs more than its analogue in the old.

The defects mentioned, though they are important, do not amount to so much that they prevent it from performing satisfactorily its peculiar function ; but they should be considered if its permanent adoption is thought of.

In considering the *material*, it remains to refer to the behavior of the piece in firing. In the different engagements which have been so imperfectly recorded, I seized the opportunity to try different kinds of fire. I will give some of the results that may serve as data for conclusions.

We fired with shell at "Potrero Pelayo ;" with shrapnel (after using shell for bracketing) in the fight at "Caimito ;" shrapnel

for percussion at "Jucaibama" and shrapnel for time at "La Reforma;" altogether 38 shell and 70 shrapnel consumed in the six months during which the platoon was engaged in military operations.

Of these, I may say that the shells burst in a very satisfactory manner. Their power of penetration may be judged by the effect of one of them in "Potrero Pelayo" which penetrated one metre into the sloping bank of the river, opening a cavity having a diameter slightly greater than that of the projectile, and disturbing, by its explosion, a column of earth about a metre in thickness, throwing out a part of it.

When we were encamped at "La Reforma" there was recovered a shrapnel, intact, except that the fuse had been blown out and also the interior tube and all the charge, tearing away, however, that part of the ogive into which the fuse was screwed; as, indeed was intended in its construction. This was the only projectile found in that condition, and from this, may be seen that the shrapnel broke and utilized the cases, which on the other hand, did not affect its value, since the shell, as is known, retains the remaining velocity, that of the bullets being increased by the velocity due to the bursting charge.

As, in most cases, the enemy was on the heights, it is not possible to vouch for the effects of the fire, on account of the facilities offered by the ground for carrying away their dead, unseen; this same characteristic of the ground made it correspondingly difficult for us to make reconnaissances. At the "Pelayo" and "Reforma" ranches, the zone of fire being relatively open, I may state that the place where a shell exploded was surrounded with blood, and in an adjoining cemetry were three new graves. At "La Reforma" a horse was found dead with seven shrapnel bullets in him. In the fight on the 7th of December, one of the reconnaissance parties reported that the explosion of a shell had caused the death of four insurgents in a village situated in the zone of fire.

The powerful bursting charge of the shrapnel, allows its substitution for the shell, employing it in percussion fire and keeping the shell for objects more difficult of penetration. For the same reason, the point of burst, in time of fire, can be observed by the quantity of smoke produced. The number of balls and their living force suggest their employment in preference to canister at point blank ranges. This would involve a change in the proportion of the different kinds of projectiles in the pack; so that each load would contain 8 shrapnel. 3 shell, and 1 canister.

Feeling, as I do, the necessity in mountain warfare of curved fire, (as the shrapnel do not begin to be effective against a short target until the angle of fall approaches 20°, corresponding to a range of 3400 metres, at which distance a battery can rarely be established), I think that it would be advisable to furnish cartridges containing reduced charges—two of these to each load—painting the shrapnel with a different combination of colors in order to distinguish it.

The fuses acted remarkably well, as there was no case in which the bursting charge of shell or shrapnel had failed to explode; nor did the fuses fail to respond to the time scale. Similarly, at no time did the percussion caps of the cartridges fail to communicate fire.

As to rapidity of fire, it is known that this depends on promptness in loading, due to the use of the metallic cartridge, which substitutes a single motion for the three motions of inserting the projectile, introducing the cartridge and adjusting the friction primer; and on rapidity of pointing due to the obviation of recoil by the use of the trail plough.

As regards the latter, it was only on a few occasions that we were able to employ it in a war like the present one, in which surprises were the rule, and the pieces were rarely in position more than a few moments. Thus it is always desirable that an artillery officer should be able promptly and judiciously to choose positions and rapidly move into them; a mountain artilleryman *must* have these characteristics. They embrace placing the battery in position and using it effectively against the enemy.

From this it follows that, the time being brief, the loss of time in putting the trail plough into its firing position is excessive, when the enemy, suddenly appearing, opens fire, or when the position is a momentary one and activity is necessary in order to pass rapidly from one position to another, The trail plough has its use when we can take advantage of its valuable attributes, as when there is time after discovering the enemy to correct the fire, which involves occupying the position for some time; in a word, when real artillery fire takes place. In such case the plough should be down in order to avoid moving the piece by hand to the front, since this movement involves loss of time and unnecessarily fatigues the cannoneers; and in rapid fire, it is absolutely necessary to supplement rapidity of loading by rapidity in pointing.

As to opportunity for firing rapidly, *that* has to be secured by prompt decision, and the first necessity in it is correction of fire,

requiring that the service of the piece be performed calmly and with care; the only safe way of efficiently using rapid fire. The fact that the pieces are called "rapid fire" guns, does not necessitate that, from the first moment, they should be fired at their maximum rate; such a course would waste many shots, and expose one to lack of ammunition when it is much needed.

In the precision and power of the piece, in the excellent quality of its projectiles, in the confidence inspired by the accuracy with which the cannoneers fire, in its range which allows to be chosen good positions and angles of fall such that shrapnel will be effective against troops more or less hidden, lies, ordinarily, the superiority which the new *materiel* represents. This leads to the belief that one or two accurate shots are worth more and have a greater moral effect than many wild ones.

In firing, ordinarily, during a fight, the piece is capable of firing as rapidly as the commands can be conveniently be given. If results are noted after each shot a piece can always be held in readiness, loaded and pointed.

As regards the number of shots per minute, its maximum rapidity of fire is, according to its constructor, eight shots per piece per minute; but although I cannot be absolutely positive, in the opinion that I have formed in firing with shell, and especially with shrapnel, I believe that, under actual service conditions, one cannot hope for a greater rate of fire than from one half to one-third of that claimed for it.

The above shows the favorable estimate that the Krupp 7.5 cm. cannon has earned with me. The working of its different parts being obsolutely certain, without interruption or necessity for replacing springs, strikers, or needles (an operation performed by the artificers in a short time and with extreme ease), deserves absolute confidence on my part.

Some modifications are necessary in the ammunition chests which are the defective part of the *materiel.* The fastening of the lid should be placed inside to avoid its injury by catching on shrubs and branches of trees; the character of lock should be changed; and the chests strengthend with strong armor.

The adoption of this piece constitutes a great advance in the mountain artiilery and places it in condition to compete with advantage with those of its class in the possession of other nations, or to reduce to silence *any* piece, whatsoever, that is in use among the insurgents; and it has all the qualities claimed by

modern artillery, although the *heroes* that fought against it do not appear to have great confidence in its power.

[Translated by Second Lieutenant *Alston Hamilton*, First Artillery.]

CONTRIBUTION TO THE STUDY OF THE PROBABILITY OF FIRE OF COAST ARTILLERY.

By Giuliano Ricci, Captain of Artillery.

Rivista di Artiglieria é Genio.

The study of the probability of fire of coast artillery, against vessels in motion, presents itself under such complex and varied conditions that it is difficult and perhaps impossible to determine with a general and complete solution, the per cent of the useful hits which may be relied upon in a series of shots that reproduce the tactical and technical condition of battle fire.

We may instead, however, find various partial solutions referring to special cases, and by means of these be able to collect some data to form certain criteria both from a tactical and technical point.

It is proposed to study here one of the simplest cases, which will not always correspond, it is true, to war conditions, but which may, however, serve as a point of departure for the examination and discussion of all other cases.

We assume two hypotheses, which determine the conditions of the problem we intend to discuss.

We will suppose

1st. That the firing has been corrected, that is, that all the causes of error which might systematically alter the results of the firing have been previously eliminated, and that the accidental errors alone need be considered, then errors being variable in sign and value in accordance with Laplace's well known law, which formed the basis for the calculation of the table of factors of probability generally adopted in ballistics.*

2nd. That the observation of the movement of the target during a certain interval furnishes a means of adjusting the aim or of anticipating the position of the target at a given subsequent instánt. Such an hypothesis is verified by the method of aiming now generally employed and includes within it the further as-

* The greater or less density of the atmosphere will diminish or increase, systematically. the range; if the piece be worn out or the powder poor, the range will be systematically short; finally, the aiming of a given individual may be systematically too high or too low, Theoretically, these systematic errors can be eliminated by preliminary firing.

Besides systematic errors, however, there are accidental ones inherent in the piece, in the aiming and in the measuring of the distance which cannot be corrected and on which the accuracy of fire depends. These errors are dispersed according to the law noted above.

sumption that the target moves with uniform motion over a right line during the time occupied in the preparation for firing.

In regard, however, to these hypotheses and to the confidence which they may deserve in practice, we must observe what follows:

a. The corrected firing against a movable target will be attained with difficulty, and even when attained, it will be almost impossible to keep it so.

Indeed, though the causes of the systematic errors may remain a maximum (some, for exomple, the wind, may vary) their effect varies with the distance and also with the direction of the firing. The corrections which must be applied to the data of firing to keep it corrected changes, therefore, continually, and we have no means of calculating it at every discharge with sufficient accuracy.*

The difficulty of attaining and maintaining the fire corrected will be the greater as the variations of the systematic errors from shot to shot are greater; it increases, therefore, with the velocity of the target and diminishes as the rapidity of fire increases.

b. It is certain that a vessel during battle will not always maintain a rectillinear route nor will it always move with a uniform velocity. Theoretically, however, it is still possible to predict the position of the target at a particular subsequent instant, even though the route is curvelinear, and the velocity variable, provided that in the interval of time required in the preparation for the firing, the movement of the vessel is maintained continuous and does not become altered in direction or velocity, from any cause, such as a variation in the number of revolutions of the propeller.

It is even possible to imagine or devise some method of solving this problem practically.

We do not occupy ourselves with this case, which, as far as we know, is still unconsidered in the field of applications.

Perhaps in this case the results will not differ materially from those which would result when we assume the motion to be uniform and in a right line. If, then, the movement of the target is not continuous, being abruptly altered by the will of its operator, it is certain that whatever be the adjustments, imagined and imaginable, of the firing, it will fail. We must, then, no longer depend upon the precision of the shots but rather upon their dispersion. The discussion, whether it would not be proper

* The corrections proportional to the distance, although theoretically correct, do not, in practice, give sufficiently accurate results, especially when, as in howitzer firing, the charges are varied.

to increase this dispersion artificially by employing graded elevations and displacements, is an absolutely distinct case which will be treated separately.

As we have before stated, it is certain that the route of the vessel will not always be a right line, nor will its velocity be uniform; we are almost equally certain that the conditions of its movement will not permit a very frequent departure from this double hypothesis, unless the vessel renounces what strength of fire it possesses, or, the target at which it is to fire is very small in extent.*

In some cases, moreover, tactical and hydrographical circumstances might concur to limit the free maneuver of the vessels.

From what has been indicated, it follows that the results obtained will be considered only as a superior limit which will probably never be reached, but which it is possible to approach under certain favorable circumstances. We hold that these circumstances will present themselves with sufficient frequency, but the experience of war will alone be able to decide this question.

Finally, we observe how, having given the methods generally employed in the firing of coast artillery, the problem here proposed corresponds to the theoretical case admitted as general and fundamental. We observe, too, that all other cases, (in which, either some systematic error is not eliminated, or the adjustment of the fire is found to be defective through an alteration in the movement of the target,) may be made to depend on the general case, in the same manner that the problem of uncentered fire is made to depend on centered fire.

* * * * * * *

In order to determine the per cent of useful hits which may be obtained against a certain target under any conditions whatever (limited, however, by the above mentioned hypotheses) it suffices to know, for the present :†

1st. That which is to be found on the subject of the calculation of probabilities in the "Artillery Practice Instructions, old volume vii, chapter ii, and in the Manual of Artillery, part iv.

2nd. A theorem of the calculus of probability which is expressed thus,

"When many independent causes produce errors in the same

* This deduced from an examination of the conditions under which a vessel in motion fires at a land target. Such fire is evidently affected by the same causes of error as those inherent in a land battery firing at a vessel in motion and to a greater extent (owing to the instability of its platform and the lesser accuracy of the range-finders used on board ship) as is abundantly confirmed by the results of every experiment.

† It is believed preferable to indicate practical rules and sources generally known to all army officers, rather than theories which require for thei investigation much time and study.

direction, we may, knowing the probable errors e_1, e_2, e_3.... which would result from the operation of any isolated cause, find the error E which results from their simultaneous action, thus,

$$E = \sqrt{e_1^2 + e_2^2 + e_3^2 \ldots}\ *$$

Applications:

1st. The probable error in range of a shot from a piece aimed with absolute precision, at a certain distance, is 10 m.; at the same distance a gunner commits an error in aiming such, that the range due to this cause alone, would give a variation whose probable error in range, E, of the shot with this particular gun and gunner will be

$$E = \sqrt{10^2 + 20^2} = 22.4 \text{ m.}$$

2nd. Assuming that we know the elevation which must be given to a particular piece to attain any mean range whatever, let us consider a piece which for a certain distance and for distances varying but little from this gives a probable range error of 15 m., and that the range-finder used to determine this distance under similar circumstances, is susceptible of an error of 30 m. The probable range error of the shot made under these conditions will then be

$$E = \sqrt{15^2 + 30^2} = 33.5 \text{ m.}$$

3rd. If AB, measured by any means gives a probable error of

A B C

7 m. and BC measured by the same means yields a probable error of 20 m., the probable error in measuring AC is

$$E = \sqrt{7^2 + 20^2} = 20.17 \text{ m.}$$

We now come to the solution of the proposed problem.

Let the target be horizontal and rectangular in form and let one of its sides lie in the direction of the fire. Let A be the length of this side, and B that of the other dimension. Let M and N be the depth and breadth of the zones containing 50% of the shots of a given piece fired under certain determinate conditions—a length and breadth which result from the combination of the various causes of error which may affect the fire (error of the piece, of the gunner, etc.).

The per cent of the useful shots will be given by the expression

* This is a theorem which, on account of its important applications, ought, in my opinion to be embodied in our Artillery Manual (author).

$$\frac{1}{100} \, P\left(\frac{A}{M}\right) \, P\left(\frac{B}{N}\right).$$

In order to solve the proposed problem we have only to substitute for A, B, M, and N the values which result from the true dimensions of the target under consideration and from the conditions of the firing.

Let $a\ b\ c\ d$ (fig. 1) be the contour of the horizontal projection of a vessel—a contour which we may assume represented by an ellipse having for axes the maximum length and breadth L and l, of the vessel—and h the mean height of the useful target which the vessel presents. Let θ represent the angle of fall and mn, which makes with ab the angle ψ, the direction of the plane of fire. Let us project upon the sea by means of the trajectory, the contour of the main bridge of the vessel, we thus obtain the ellipse $a_1\ c_1\ b_1\ d_1$; and the effective target which the vessel presents will be equivalent to the horizontal boundary of the contour $p\ m\ q\ q_1\ n_1\ p_1$, *i. e.*, of portions of two ellipses and of two tangents common to them and parallel to the plane of fire. We will assume (and we can do so with great approximation) that this last target is equivalent to a rectangle whose length is $mn = A$ and whose breadth B is such that its area is equal to that limited by the boundary $p\ m\ q\ q_1\ n_1\ p_1$.*

* Let $A = mn + \dfrac{h}{\tan\theta}$.

To find mn proceed as follows:
The equation of our ellipse whose axes are L and l is

$$\frac{x^2}{L^2} + \frac{y^2}{l^2} = \frac{1}{4}.$$

From the figure (1a) we have

$$x = \frac{1}{2}\, mn \cos\psi$$

and

$$y = \frac{1}{2}\, mn \sin\psi$$

Substituting these values of x and y in the above equation and solving for mn we obtain

$$mn = \frac{Ll}{\sqrt{l^2\cos^2\psi + L^2\sin^2\psi}} = \frac{Ll}{\lambda}$$

when for $\sqrt{l^2\cos^2\psi + L^2\sin^2\psi}$ we substitute λ.

Substituting this value of mn in the first of the above equations we obtain

$$A = \frac{Ll}{\lambda} + \frac{h}{\tan\theta}.$$

The area enclosed by the contour $p\ m\ q\ q_1\ n_1\ p_1$ is equal to that of the ellipse having L and l for axes plus that of the parallelogram $p\ q\ q_1\ p_1$. The area of the ellipse is $\frac{1}{4}\pi Ll$ and of the parallelogram is $\dfrac{h}{\tan\theta}\, st$. Now st is the projection of the diameter pq upon the right line perpendicular to the plane of fire; let ψ be the angle between the two conjugate diameters pq and mn, then will $st = pq \sin\psi$, but from the well known property of conjugate diameters we have

$$(mn)\,(pq)\sin\psi = Ll.$$

Hence

$$st = \frac{Ll}{mn} = \lambda.$$

Finally we have

$$B = \frac{\frac{1}{4}\,Ll + \dfrac{h}{\tan\theta}\,\lambda}{A}.$$

By means of the characteristic relations between the elements of an ellipse, we find

$$A = \frac{Ll}{\sqrt{l^2 \cos^2 \psi + L^2 \sin^2 \psi}} + \frac{h}{\tan \theta}$$

$$B = \frac{\frac{\pi}{4} Ll + \frac{h}{\tan \theta} \sqrt{l^2 \cos^2 \psi + L^2 \sin^2 \psi}}{\frac{Ll}{\sqrt{l^2 \cos^2 \psi + L^2 \sin^2 \psi}} + \frac{h}{\tan \theta}};$$

Placing

$$\sqrt{l^2 \cos^2 \psi + L^2 \sin^2 \psi} = \lambda$$

we obtain

$$A = \frac{Ll}{\lambda} + \frac{h}{\tan \theta}$$

and

$$B = \frac{\frac{\pi}{4} Ll + \frac{h}{\tan \theta} . \lambda}{A}.$$

Let us now proceed to the investigation of M and N.

The dispersion of the shots in the direction of the range depends essentially upon:

1st. The irregularities inherent in the piece itself and in the ammunition (we will indicate by ΔT the probable error due to this cause).

2nd. The probable error due to the aiming, which we will indicate by ΔP.

3rd. The probable error committed in the estimation of the range, which we will indicate by ΔX.

We will thus have

$$M = 2 \sqrt{\overline{\Delta T}^2 + \overline{\Delta P}^2 + \overline{\Delta X}^2}.$$

Let us see how we may determine the three quantities under the radical.

The error ΔT is half the depth of the 50% zone as given in the tables of fire. We must observe, however, that under ordinary circumstances materials and munitions are not in as good condition as they were when the experiments upon which the tables were based, were made. On the other hand, the zones given in the table of fire, combine the errors of piece and gunner, made under the best conditions. At the same time the accuracy of the piece which results from the table of fire, will certainly be considered as a superior limit which in practice will be reached with difficulty.

The error ΔP is only deduced from the tables of fire, when

the probable angular error which is committed in giving elevation to the piece is known. The elevation may be accomplished either by causing the prolongation of the line of sight to pass through the target or by adopting a suitable elevation indicator. The errors themselves will necessarily depend on the means employed in aiming and can only be determined by experiment.

The determination of the error $\triangle X$ is somewhat more complicated than the preceding.

In order to regulate the fire, we have a range-finder of some system capable of measuring the distance X from the battery to the target with a certain probable error which is a function of this distance and which we will indicate by dX.*

The range corresponding to the elevation given to the piece is composed of two parts; the first, which we denote by y, is the distance of the target when the command *fire* is given: the second, denoted by z, is the space over which the target has approached or withdrawn itself from the battery during the pas-

* Coast artillery range finders, at least those in use in Italy, belong to the following three distinct types:

1st. Range finders with vertical bases.

Let one of these instruments be placed in a battery at a height H and let $d\epsilon$ be the probable error with which it is capable of measuring the angle ϵ of depression of the target with respect to the battery (fig. 2a).

We will have then

$$dX = \frac{X^2}{H}\, d\epsilon.$$

2nd. Range finders with horizontal bases.

Such range finders usually have two angle measuring instruments at the extremeties of a fixed base. Let one of these instruments be placed in a battery at A (fig. 3a) and the other at an external station B at a distance D from A.

Let a be the angle BAC and let da be the probable error with which the two instruments can measure the angles A and B respectively.

We will have then

$$dX = \sqrt{\frac{X^2\,(X - D\cos a)^2 + (X^2 + D^2 - 2\,D\,X\cos a)^2}{D^2\sin^2 a}}\,.da.$$

If D is very small as compared with X, we may write with sufficient accuracy

$$dX = \frac{X^2\,\sqrt{2}}{D\sin a}\,da,$$

or better

$$dX = \frac{X\,\sqrt{2}}{\sin\gamma}\,da,$$

in which γ = angle ACB.

3rd. External range finders, consisting of double zenith and azimuth angle measuring instruments.

Let A (fig. 4a) be the position of the battery, and B, at a height H and distance D from the battery, the position of the instrument. The point C represents the position of the target.

Then, da and $d\epsilon$ being the probable errors with which the instrument is capable of measuring the horizontal and vertical angles respectively we obtain

$$dX = \sqrt{\frac{D^2\sin^2 a\,(X - D\cos a)^2 + (X - D\cos a)^4}{H_1{}^2}\,d\epsilon^2 + D^2\sin^2 a\,da^2}.$$

This, may, with sufficient accuracy, be written

$$dX = \frac{X_1{}^2}{H_1}\cos\gamma\, d\epsilon$$

and in the majority of cases may be still further simplified, thus:

$$dX = \frac{X_1{}^2}{H_1}\, d\epsilon.$$

The quantities $d\epsilon$ and da must be determined by experiment to be deserving o faith in all cases.

sage of the projectile from the gun to the target, including in this time the few instants necessary to transmit and execute the command "fire."

We thus have

$$X = y \pm z.$$

If we determine y and z separately by committing the errors dy and dz we will have

$$\Delta X = \sqrt{dy^2 + dz^2}.$$

The distance y may be determined by a single observation with the range finder, and the error dy is afterwards calculated by the formula specially determined for the particular range finder used.

We may thus assume $dy = dx$.

To determine the quantity z, the rational procedure, from which all those generally adopted differ only in the mode of execution, is as follows: we measure the distance to the target at a certain instant and then again after t seconds; let y_1 and y_2 be the results of the two measurements, then if the time of flight (increased by the time necessary to command and fire) is τ seconds we have

$$z = \frac{y_1 - y_2}{t} \tau.$$

The value of z thus calculated will be affected by an error dz resulting from those committed in the measurement of the four quantities y_1, y_2, t and τ.

We will denote these errors by dy_1, dy_2, dt and $d\tau$, respectively.

The errors dy_1 and dy_2 depend on the range finder, that of dt upon the observer, who may not execute the measurement of y_1 and y_2 at the precise instant signaled, so that the time which elapses between the two observations will not be exactly t seconds, and that of $d\tau$ upon the variation of the interval of time necessary to command and execute the firing.

Each of the errors dy_1, dy_2, dt, $d\tau$, considered alone has, in the value of z, an error equal to

$$\frac{dz}{dy_1} dy_2 = \frac{\tau}{t} dy_1.$$

$$\frac{dz}{dy_2} dy_2 = -\frac{\tau}{t} dy_2.$$

$$\frac{dz}{dt} dt = \frac{(y_2 - y_1)}{t_2} \tau dt.$$

$$\frac{dz}{d\tau} d\tau = \frac{y_1 - y_2}{t} d\tau.$$

Consequently we will have

$$dz = \sqrt{\left(\frac{\tau}{t}\right)^2 dy_1^2 + \left(\frac{\tau}{t}\right)^2 dy_2^2 + \left(\frac{\tau}{t^2}\right)^2 (y_1 - y_2)^2 dt^2 + \frac{(y_1 - y_2)^2}{t^2} d\tau^2}.$$

Since y_1 and y_2 approximate very closely to x, we may place $dy_1 = dy_2 = dx$; also, assuming v to be the component of the velocity of the target in the direction of the fire we have

$$\frac{y_1 - y_2}{t} = v_1.$$

Substituting dx for dy_1 and dy_2 and v_1 for $\frac{y_1 - y_2}{t}$ in the above expression for dz we obtain

$$dz = \sqrt{2 \frac{\tau^2}{t^2} dx^2 + v_1^2 \left(\frac{\tau^2}{t^2} dt^2 + d\tau^2\right)}.$$

With a careful operator at the range finder and with reliable assistants at the battery, dt and $d\tau$ will be so small that the second term under the radical may almost always be considered as negligible and the expression then becomes

$$\left[dz = \frac{\tau}{t} \sqrt{2\, dx^2}\right]$$

$$dz = \frac{\tau}{t} \sqrt{2}\, dx.$$

Substituting, finally, this value of dz in the expression for ΔX we obtain

$$\Delta X = dx \sqrt{1 + 2 \frac{\tau^2}{t^2}}.$$

The dispersion of the shots in a lateral direction is produced:

1st. By the inherent error in the piece which we will indicate by $\Delta_1 T$.

2nd. By the error of the gunner $\Delta_1 P$.

3rd. By the error $\Delta_1 S$, committed in the calculation of the space passed over by the target, during the flight of the projectile, in a direction normal to the plane of fire.

We will thus have

$$N = 2 \sqrt{\Delta_1 T^2 + \Delta_1 P^2 + \Delta_1 S^2}.$$

The probable error $\Delta_1 T$ is half the width of the 50% zone and is found in the table of fire.

The probable error $\Delta_1 P$ is evidently $X da$, X being the distance to the target and da the probable angular error, made laterally, from the direction given to the piece.

This error depends upon the means of aiming employed.

To calculate the space S passed over by the target during flight, normal to the direction of fire, we follow a method analogous to that pointed out for determining the displacement z in the direction of fire.

In the range finding station, there is always found an azimuth instrument, either attached to the range finder directly or independent of it.

Let $d\alpha$ be the probable angular error which an observer using this instrument makes in measuring the angle α, which a direct sight from the station to the target makes with any other direction whatever.* Let α_1 be this angle at a certain instant and α_2 its value after t seconds. The angular displacement $\alpha_1 - \alpha_2$ will evidently correspond to a linear one of $(\alpha_1 - \alpha_2)$ X, so that for the time τ we will have

$$S = \frac{\alpha_1 - \alpha_2}{t} X\tau.$$

Proceeding in the same manner that we did to obtain dz we obtain

$$\Delta S = d\alpha X \frac{\tau}{t} \sqrt{2}.$$

We thus have all the data that we require for the solution of the proposed problem.

To sum up—the per cent of shots upon which we may rely in firing against a vessel in motion is given by the expression

$$\frac{1}{100} P\left(\frac{A}{M}\right) P\left(\frac{B}{N}\right).$$

In which

$$A = \frac{Ll}{\lambda} + \frac{h}{\tan\theta}.$$

$$B = \frac{\frac{\pi}{4} Ll + \frac{h}{\tan\theta}\lambda}{A}$$

In which

$$l' = \sqrt{l^2 \cos^2 \varphi + L^2 \sin^2 \varphi}.$$

$$M = 2\sqrt{\Delta T^2 + \Delta P^2 + \Delta X^2}$$

$$\Delta X = dX \sqrt{1 + 2\frac{\tau^2}{t^2}}$$

* In the case of a range finder at the battery, the error $d\alpha$ depends simply upon the instrument and upon the observer and is always the same; for a range finder external to the battery we have, instead:

$$d_r\alpha = \sqrt{\frac{(X - D\cos\alpha)^2 D^2 \sin^2\alpha + D^4 \sin^4\alpha}{X^2 H_1^2} d\epsilon^2 + \frac{(X - D\cos\alpha)^2 d\alpha^2}{X^2}}$$

the notation adopted is the same as that in note page 305.

$$N = 2\sqrt{\Delta_1 T^2 + \Delta_1 P^2 + \Delta S^2}.$$

$$\Delta S = da \times \frac{\tau}{t}\sqrt{2}.$$

To illustrate the steps of the calculations and in order to give an idea of the results which may be attained with the methods and formulæ developed above, we have determined the probability of fire for various distances of a 24 G. R. C., short, rifle (fired at Grenada) situated in a battery at a height of 100 m., and of a 28 G. R. C. howitzer situated in a battery at a height of 191 m.

Let us suppose

1st. That the probable angular error of aiming in elevation is 2′ for the rifle and 3′ for the howitzer (for the latter, such an error produces an almost negligible influence).

2nd. That the probable lateral error is 2′ for both pieces.

3rd. That, in order to determine the distance, we have at the battery a vertical base range finder, capable of measuring vertical angles with a probable error $d\varepsilon = 0.0001$ (about 20″) and horizontal angles with a probable error $da = .0002$.

4th. That 10″ are required to measure the components of the velocity of the target and 2″ to command and execute the fire.

5th. That the vessel against which the fire is directed has the following dimensions: $L = 100$ m. $l = 20$ m. $h = 5$ m.

6th. That the angle ψ (angle between the axis of the vessel and the plane of fire) has successively values from 0° to 90°.

The results of the calculations are given in the following tables:

24 G. R. C. (short) rifle, H = 100.

TABLE I. Values of A (depth of target).

Distances.	VALUES OF ψ.							
	0°	10°	15°	20°	30°	45°	60°	90°
1000	138	114	100	89	76	66	61	58
1500	142	118	104	93	80	70	65	62
2000	141	117	103	92	78	68	64	61
2500	136	112	98	87	74	64	59	56
3000	130	107	92	82	68	58	53	50
3500	126	102	88	77	64	54	49	46
4000	122	98	84	73	60	50	45	42
5000	117	93	79	68	54	44	40	37
6000	113	89	78	64	51	41	36	33
7000	110	87	72	62	48	38	34	30
8000	108	84	70	59	46	36	31	28
9000	109	82	68	57	44	34	29	26

24 G. R. C. (short) rifle, H = 100.

TABLE II. Values of B (breadth of target.)

Distances.	VALUES OF ϕ.							
	0°	10°	15°	20°	30°	45°	60°	90°
1000	17	23	28	34	47	65	80	92
1500	17	23	28	35	48	66	80	93
2000	17	23	28	35	48	67	80	93
2500	17	23	28	34	47	66	79	92
3000	17	22	28	34	47	65	79	91
3500	17	22	27	34	46	64	78	90
4000	16	22	27	33	45	63	77	89
5000	16	21	27	32	45	62	76	88
6000	16	21	26	32	44	61	75	87
7000	16	21	26	32	44	60	74	85
8000	16	21	26	32	43	60	73	84
9000	16	21	26	32	43	59	72	83

24 G. R. C. (short) rifle, H = 100.

TABLE III. Values of M (depth of the 50 % zone).

X	dX	$\frac{r}{t}$	$\frac{r^2}{t^2}$	$1+2\frac{r}{t^2}$	$\overline{\Delta X^2}$	$\overline{\triangle T^2}$	$\triangle P^2$	M
1000	1	0.44	0.1936	1.3872	1.50	20	21	13
1500	2.25	0.57	0.3249	1.6498	8.35	49	58	21
2000	4	0.71	0.5041	2.0082	32	90	95	29
2500	6.25	0.86	0.7396	2.4792	97	144	114	38
3000	9	1.02	1.0404	3.0808	249	210	120	48
3500	12.25	1.18	1.3924	3.7848	568	306	121	63
4000	16	1.35	1.8225	4.6450	1189	420	114	83
5000	25	1.72	2.9584	6.9168	4323	576	100	141
6000	36	2.12	4.4944	9.9888	12945	784	81	235
7000	49	2.57	6.6049	14.2098	34118	1056	64	376
8000	64	3.10	9.6100	20.2200	82821	1406	36	580
9000	81	3.75	14.0625	29.1250	191089	1806	25	878

24 G. R. C. (short) rifle, H = 100.

TABLE IV. Values of N (breadth of the 50 % zone).

X	$\frac{r}{t}$	$2\alpha^2X^2$	ΔS^2	$\overline{\Delta_1 T^2}$	$\overline{\triangle_1 P^2}$	N
1000	0.1936	0.08	0.015	0.02	0.36	1
1500	0.3249	0.18	0.058	0.04	0.71	2
2000	0.5041	0.32	0.16	0.12	1.44	3
2500	0.7396	0.50	0.37	0.36	2.25	3
3000	1.0404	0.72	0.75	0.72	3.24	4
3500	1.3924	0.98	1.36	1.21	4.41	5
4000	1.8225	1 28	2.33	1.96	5.76	6
5000	2.9584	2.00	5.92	4	9.	9
6000	4.4944	2.88	12.93	7.29	12.96	12
7000	6.6049	3.92	25.87	12.96	17.64	15
8000	9.6100	5.12	49 20	21.16	23.04	19
9000	14 0625	6.48	91.11	31.38	29.16	25

24 G. R. C. (short) rifle, H = 100.

TABLE V. Per cent of useful shots.

X	VALUES OF ψ.							
	0°	10°	15°	20°	30°	45°	60°	90°
1000	100	100	100	100	100	100	100	100
1500	100	100	100	100	99	97.5	96	95
2000	100	97	98	97	93	88.5	86.5	84.5
2500	98.5	95	92	88	81	74	70	68
3000	92	87	80.5	75	66	59	54	52
3500	80	72.5	65	59	50.5	43.5	40	37.5
4000	62	56	50.5	45	37	31.5	28.5	27
5000	33	31	28	25	20	16.5	15	14
6000	16.5	15.5	15	13.5	11	9	8	7.5
7000	8	8	7.5	7	6.5	5.5	5	4.5
8000	4.5	4	4	4	4	3	2.5	2.5
9000	2	2	2	2	2	1.5	1.5	1.5

28 G. R. C. Howitzer, H = 191.

TABLE I. Values of A (depth of target).

Charge.	X	VALUES OF ψ.							
		0°	10°	15°	20°	30°	45°	60°	90°
I	900	112	88	74	63	56	40	35	32
	1200	110	86	72	61	48	38	33	30
	1600	109	85	71	60	47	37	32	29
	2150	105	81	67	56	43	33	28	25
II	1300	114	90	76	65	52	42	37	34
	1800	112	88	74	63	50	40	35	32
	2400	109	85	71	60	47	37	32	29
	3050	105	81	67	56	43	33	28	25
III	2500	113	89	75	64	51	41	36	33
	3000	112	88	74	63	50	40	35	32
	3700	109	85	71	60	47	37	32	29
	4650	105	81	67	56	43	33	28	25
IV	3550	113	89	75	64	51	41	36	33
	4000	111	87	73	62	49	39	34	31
	4700	109	85	71	60	47	37	32	29
	5800	105	81	67	56	43	33	28	25
V	4700	112	88	74	63	50	40	35	32
	5400	110	86	72	61	48	38	33	30
	6400	107	83	69	58	45	35	30	27
	7400	104	80	66	55	42	32	27	24
VI	5850	110	86	72	61	48	38	33	30
	6300	109	85	71	60	47	37	32	29
	7100	106	82	68	57	44	34	28	26
	7950	104	80	66	55	42	32	27	24

28 G. R. C. Howitzer, H = 191.

TABLE II. Values of B (breadth of target.)

Charge.	X	VALUES OF ϕ.							
		0°	10°	15°	20°	30°	45°	60°	90°
I	900	16	21.5	26.5	32	44	61	75	86.5
	1200	16	21	26	32	44	60	74	85.5
	1600	16	21	26	32	43.5	60	73.5	85
	2150	16	21	26	31	43	58.5	71.5	82
II	1300	16	21.5	26.5	32.5	44.5	61	75	87
	1800	16	21.5	26.5	32	44	61	75	86.5
	2400	16	21	26	32	43.5	60	73.5	85
	3050	16	21	26	31	43	58.5	71.5	82
III	2500	16	21.5	26.5	32	44	61	75	86.5
	3000	16	21.5	26.5	32	44	61	75	86.5
	3700	16	21	26	32	43.5	60	73.5	85
	4650	16	21	26	31	43	58.5	71.5	82
IV	3550	16	21.5	26.5	32	44	61	75	86.5
	4000	16	21	26	32	44	60.5	74.5	86
	4700	16	21	26	32	43.5	60	73.5	85
	5800	16	21	26	31	43	58.5	71.5	82
V	4700	16	21.5	26.5	32	44	61	75	86.5
	5400	16	21	26	32	44	60	74	85.5
	6400	16	21	26	32	43	59	73	84
	7400	16	21	26	31	42.5	58	71	82
VI	5850	16	21	26	32	44	60	74	85.5
	6300	16	21	26	32	43.5	60	73.5	85
	7100	16	21	26	31.5	43	59	72	83.5
	7950	16	21	26	31	42.5	58	71	82

28 G. R. C. Howitzer, H = 191.

TABLE III. Values of M (depth of the 50 % zone).

Charge.	X	ΔX	$\frac{\tau}{t}$	$\frac{\tau^2}{t^2}$	$1+2\frac{\tau^2}{t^2}$	$\overline{\Delta X^2}$	$\overline{\Delta T^2}$	$\overline{\Delta P^2}$	M
I	900	0.44	0.84	0.71	2.42	0.47	6	9	8
	1200	0.77	1.07	1.14	3.28	1.94	30	6	12
	1600	1.37	1.42	2.02	5.04	9.45	70	6	19
	2150	2.45	2.09	4.37	9.74	58.46	169	0.25	30
II	1300	0.90	0.97	0.94	2.88	2.33	4	16	9
	1800	1.72	1.29	1.66	4.32	12.79	16	16	13
	2400	3.05	1.75	3.06	7.12	66.20	72	12	24
	3050	4.91	2.60	6.76	14.52	349.93	182	0.25	46
III	2500	3.31	1.41	1.99	4.98	54.58	30	36	22
	3000	4.76	1.68	2.82	6.64	150.46	64	30	31
	3700	7.22	2.11	4.45	9.90	516.09	169	25	53
	4650	11.38	3.11	9.67	20.34	2643.38	324	2	109
IV	3550	6.65	1.75	3.06	7.12	315	110	56	44
	4000	8.44	1.99	3.96	8.92	635	156	49	58
	4700	11.63	2.40	5.76	12.52	1685	240	36	88
	5800	17.70	3.57	12.74	26.48	8296	441	4	187

TABLE III. (Continued).

Charge.	X	ΔX	$\frac{r}{t}$	$\frac{r^2}{t^2}$	$1+2\frac{r^2}{t^2}$	$\overline{\Delta X^2}$	$\overline{\Delta_1 T^2}$	$\overline{\Delta P^2}$	M
V	4700	11.63	2.02	4.08	9.16	1233	196	81	78
	5400	15.35	2.38	5.66	12.32	2884	289	72	114
	6400	21.55	2.99	8.94	18.88	8727	420	42	192
	7400	28.82	4.19	17.56	36.12	29959	600	0.25	350
VI	5850	18.01	2.47	6.10	13.20	4277	324	81	137
	6300	20.89	2.71	7.34	15.68	6850	400	73	171
	7100	26.53	3.24	10.50	22.00	15449	529	36	254
	7950	33.26	4.15	17.22	35.44	39299	650	1	400

28 G. R. C. Howitzer, H = 191.

TABLE IV. Values of N (breadth of the 50 % zone).

Charge.	X	$\frac{r^2}{t^2}$	$\overline{2\Delta\alpha^2 X^2}$	$\overline{\Delta S^2}$	$\overline{\Delta_1 T^2}$	$\overline{\Delta P^2}$	N
I	900	0.71	0.06	0.04	1	0.29	2.3
	1200	1.14	0.11	0.12	1	0.52	2.5
	1600	2.02	0.20	0.40	2	0.92	3.5
	2150	4.37	0.37	1.62	4	1.66	5.5
II	1300	0.94	0.13	0.12	1	0.60	2.5
	1800	1.66	0.26	0.43	2	1.17	4
	2400	3.06	0.46	1.41	4	2.07	5.5
	3050	6.76	0.74	5.00	9	3.35	8.5
III	2500	1.99	0.50	0.99	6	2.25	5.5
	3000	2.82	0.72	2.03	4	3.24	6.5
	3700	4.45	1.09	4.85	12	4.93	9.5
	4650	9.67	1.73	16.73	20	7.78	13.5
IV	3550	3.06	1.01	3.09	9	4.53	8
	4000	3.96	1.28	5.07	12	5.76	9.5
	4700	5.76	1.77	10.19	20	7.95	12.5
	5800	12.74	2.69	34.27	40	12.11	18.5
V	4700	4.08	1.77	7.22	12	7.95	10.5
	5400	5.66	2.09	11.83	16	9.42	12
	6400	8.94	3.28	29.32	25	14.75	16.5
	7400	17.56	4.38	76.91	49	19.71	24
VI	5850	6.10	2.74	16.71	30	12.32	15.5
	6300	7.34	3.17	23.27	36	14.28	17
	7100	10.50	4.03	42.31	56	18.15	21.5
	7950	17.22	5.06	87.13	90	22.75	28

28 G. R. C. Howitzer, H = 191.

TABLE V. Per cent of useful shots.

Charge.	X	VALUES OF ψ.						
		0°	15°	20°	30°	45°	60°	90°
I	900	100	100	100	100	100	100	99.5
	1200	100	100	100	99.5	97	94	90
	1600	100	99	97	90	81	74	69
	2150	93	87	79	66	54	47	42.5
II	1300	100	100	100	100	100	99.5	99
	1800	99.5	100	100	99	96	93	90
	2400	95	95.5	91	81.5	70	63	59
	3050	70	64.5	58	47	37	32	28.5
III	2500	95	98	95	88	79	73	68.5
	3000	88.5	88	83	72	62	55.5	51.5
	3700	61.5	59	54	45	36	31.5	29
	4650	27.5	26	24	20	16	13.5	12.5
IV	3550	76	73	66.5	57	47	42	38.5
	4000	59	61	51.5	43	35	30.5	28
	4700	36.5	35	32	27.5	22.5	19	17.5
	5800	13	12.5	12	11	9	8	7
V	4700	45.5	43.5	40	33.5	27	24	22
	5400	30	28.5	26	22	17.5	15.5	14
	6400	14	13.5	13	11.5	10	8	7.5
	7400	5	5.5	5	5	4.5	4.5	4
VI	5850	21	20.5	19	17.5	15	13	12
	6300	16	15.5	14.5	13.5	11.5	10	9
	7100	8.5	8.5	8	7.5	6.5	6	5.5
	7950	4	4	4	4.5	4	35.	3

With distances as abscissas and probability per cent as ordinates (Table V), various curves may be traced corresponding to different values of ψ which will give the probability of fire for any distance whatever. For howitzers, on account of the variation of the charges, we will have, instead of a single curve, a bundle of curves, which will be partly superimposed and partly continuations of each other. For simplicity, a single curve, which is the mean of the whole bundle, will be substituted for it.

Between what limits will the angle ψ be practically comprised? This depends upon a number of tactical and technical circumstances and will vary accordingly. We will assume, however, that it may vary with equal probability from 0° to 90°.

A curve may now be traced which will represent for any range whatever, the mean probability of all those which are inherent to the various possible values of ψ.

Again, by laying off the different values of ψ as abscissas and the corresponding values of the probability as ordinates, we may, either from the data contained in table V, or by the transforma-

tion of the curves in figs. 6a and 7a obtain those of figs. 8a and 9a, each of which represents the probability of fire for a given range when the angle ψ varies from 0° to 90°.

By means of Simpson's quadrature formula we can calculate the altitude of the equivalent retangle, that is, the altitude of the retangle whose area is equal to the area contained between the curve, its axes and the extreme ordinates corresponding to $\psi = 90°$.

This altitude will represent the mean probability for the range corresponding to the curve considered. We thus obtain the elements for tracing the curve of figure 10a.

The discussion of the above formulae and their application to the varied conditions which may be met with in practice, leads as was said in the beginning, to results which are important tactically as well as technically. We will now call attention to same of these deductions as a corollary to what has already been deduced.

The elements which show the total offensive value which a battery or group of batteries may acquire over a given zone, are essentially: the number of pieces which fight that zone, their celerity of fire, the importance of the effect of their shots and the proportion of the useful shots upon which reliance may be placed.

This last element has certainly an importance equal to that of the others and furnishes abstractions which may lead to dangerous illusions.

On the other hand, in connection with the results obtained with the above formulas, we believe it necessary to repeat what was stated in the beginning, namely, that these results represent only a superior limit to which we may approximate whenever we realize a combination of the most favorable circumstances.

In order to really attain these results, it is supposed:

1st. That the firing is constantly corrected, but. as has already been pointed out, this hypothesis will be admissible only at intervals and even then with greater or less approximation.

2nd. That the route of the target can be predicted; we believe that this hypothesis will be quite frequently verified; if, however, it is not verified, or so to speak, is only verified at intervals of greater and less length depending upon the liberty of maneuvre which the tactital and hydrographical circumstances and the object to be obtained, leave to the target, the probability of fire may be found notably reduced.*

* A vessel free in its movements may give rise to a large number of varied cases, to which correspond different probabilities. It is not intended to examine them here nor even to attempt a more or less synthetical solution; we observe only, that, calculating a certain

3rd. Finally, that we have considered all the obstructions, all the difficulties, all the errors imputable to the external circumstances, the materiel and especially the personnel, which latter has a preponderating influence upon the success of any fighting, whatever its kind.

In a word, the results which we have found correspond to the hypothesis that everything is conducted in the best and most favorable manner, in all that concerns the target, the external circumstances, the command and the service of the battery.

In order to obtain the per cent of the useful shots upon which we may rely when this does not happen—and it will not happen in the majority of cases—we will have to multiply the results furnished by the calculations by a coefficient of reduction.

It is difficult to determine, a priori, what this coefficient ought to be, since it depends upon a quantity of variable circumstances which it is difficult to subject to calculation. Experiments, too, furnishes few hints, specially worthy of note, because in peace firing we never succeed in reproducing either the technical or tactical conditions of battle fire. Nevertheless, a certain experience in firing and the synthetical study of the various causes of error which influence it, may lead to the formulation of some included creterion, whose accuracy may certainly be open to discussion but which may yet be adopted for lack of more certain elements.

In my opinion, when considering firing executed under conditions neither excessively favorable nor yet too unfavorable, this coefficient of reduction may be taken to lie between ¾ and ½; the former being nearer for cannon, the latter for howitzer. This, however, is an exclusively personal approximation.

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number of examples whose data of departure are so chosen as to depend upon the kind and upon the particular conditions of the fighting expected, we will obtain sufficient criteria to determine the probability of fire for the cases which deviate from those considered as normal To solve these problems the method to be pursued is that adopted in the calculation of the probability of non-centered fire.

As an example chosen from those most unfavorable, let us assume a vessel, of the type already considered, to be passing over the path M N (fig. 11a) with a velocity of 5 m. per second (about 10 knots). At B is a battery of 28 G. R. C. howitzers (H = 191). When the vessel reaches A a salvo is fired from the battery; at the same instant, the vessel changes direction, describing the arc A Q—assumed to be a circle with a radius of say 200 m. (We note that in order that this most unfavorable case occur, the helms must have been pushed to one side 10 or 15 seconds earlier).

We will suppose, moreover, though it is not necessarily true, that the velocity of the vessel remains unaltered and that its axis (middle point) is always tangent to the curve of evolution (Concerning the movement of vessels under the action of the helm, see White's *Manual of Naval Architecture*, also Guyon's *Théorie du navire*.

If the vessel had continued its route till the projectile had terminated its trajectory, it would have reached a certain point O which would have been the center of impact. Let us suppose B O = 4700 m.; the time of flight increased by 2 seconds, being then 24 seconds (charge No. IV), the distance A O is 120 m. Assume B O M = 90°. Due to the change of direction the vessel will be at Q instead of at O, at the end of the 24 seconds. The coordinates of Q referred to M N and Y Y′ are $x = 7$ and $y = 35$ m. The angle ψ made by the axis of the vessel with the plane of fire is about 56°, and to this angle corresponds a depth of target A = 33 m. and a width B = 70 m. By means of these data and that furnished by the tables III and IV, we find the per cent of the useful shots to be 17.2, which is equal to that which would have been obtained had the vessel continued the initial route.

If the point B were on the prolongation of M N we would have $\psi = 34°$, A = 44 m. and B = 48 m. and the resulting % would be 3.

From the results which we have obtained, we should deduce that the probability of fire is independent of the velocity of the target—a deduction verified with difficulty in practice.

We observe, indeed:

1st. That the greater the velocity of the target, the greater is the difficulty of keeping the fire corrected.

2nd. That to greater velocities must correspond greater errors in the manipulation of the range finders and in the aiming, especially when the latter is accomplished by directing the line of sight upon the target.

3rd. That by increasing the velocity, we increase various small errors, already discussed, the sum total of which might, under certain circumstances, no longer be negligible, but would certainly increase the errors due to the difficulties and inevitable delays, even with the best instructed personnel.

In practice, for all these reasons, a somewhat smaller probability ought to correspond to the greater velocities and consequently a smaller coefficient of reduction than that indicated above.

We have deduced the formula:

$$M = 2\sqrt{\overline{\Delta T}^2 + \overline{\Delta P}^2 + \overline{\Delta X}^2}$$

in which

$$\Delta X = dX\sqrt{1 + 2\frac{\tau^2}{t^2}},$$

and the other one:

$$N = 2\sqrt{\overline{\Delta_1 T}^2 + \overline{\Delta_1 P}^2 + \overline{\Delta S}^2},$$

in which

$$\Delta S = d\alpha X \frac{\tau\sqrt{2}}{t}.$$

These formulas show the inaccuracy of the oft repeated affirmation that almost as many hits are made against a moveable target as against a stationary one.

An affirmation, so general, is perhaps not intended by those even who make it. Against a stationary target the firing may always be corrected after a few shots; there is no concern about the inherent error of the range finder, nor the irregular movement of the target—conditions certainly not avoided under any other circumstances. I maintain, rather, that this expression only signifies that, when the conditions assumed in the preparation for firing are verified, we eliminate, by this means, completely, the error due to the displacement of the target from the

instant in which the distance to it is measured to that in which the projectile completes its trajectory.

To this conception correspond the formulas

$$M = 2\sqrt{\Delta T^2 + \Delta P^2 + \Delta X^2}$$

and

$$N = 2\sqrt{\Delta_1 T^2 + \Delta_1 P^2}.$$

These formulas with a change in symbols have also been adopted by Lieutenant Calichiopulo.

But as Captain Rivals says, if the range finder is not accurate (and it is never absolutely so), when we determine the correction to be applied to the data of firing to compensate for the displacement of the target, we commit a new error which is of the same order as that due to the range finder and increases the error committed in the measurement of the range by diminishing further the precision of the firing.

The methods which we have developed and the formulae which we have deduced are but the analytical development of this conception.

The use of the formula corresponding to the hypothesis relating to the stationary target leads, quite naturally, to results which are found to be mainly errors in excess especially for the greater distances (see figs. 12a and 13a).

Among the various quantities upon which the value of M. depends, that which increases most rapidly with an increase in the distance and which therefore has the greatest influence in diminishing the per cent of useful shots, is the error proceeding from the operation of the range finder or ΔX. Let us see under what conditions this error has the least value and consequently corresponds to the greatest probability of fire.

We have found

$$\Delta X = dX\sqrt{1 + 2\frac{\tau^2}{t^2}}.$$

A simple glance at this formula shows:

1st. That ΔX diminishes with dX, i. e., with the error of the range finder: if, for example, the adopted range finder has a vertical base, we have

$$dX = \frac{X^2}{H}\,d\varepsilon;$$

ΔX diminishes, therefore, as the height of the battery increases and as $d\varepsilon$ diminishes. In figures 14a and 15a are traced probability curves for the 24 G. R. C. short cannon situated at heights

above the level of the sea of 50 m. and 100 m., and for the 28 G. R. C. howitzer situated at heights of 50, 191 and 666 m's., by assuming in each case that the probable angular error of the adopted range finder is

$$d\varepsilon = 0.0001.$$

Identical results would be obtained by assuming we had two 24 G. R. C. short cannon, at a height of 100 m. the probable range finder error being $d\varepsilon = 0.0002$, and three 28 G. R. C. howitzers at a height of 191 m., the probable range finder error being, respectively, $d\varepsilon = 0.0001 \left(\frac{191}{50}\right)$, $d\varepsilon = 0.0001$, and $d\varepsilon = 0.0001 \left(\frac{191}{666}\right)$. (See figures 14a and 15a).

Hence we see that an increase in the precision of the range finder may be obtained either by increasing the height of the station or by perfecting the instrument, or the same result may be obtained by increasing the number of pieces.

2nd. ΔX increases or diminishes as the time of flight τ increases or diminishes. This is one of the causes, though not always the most important, on account of which a greater probability of fire ought to correspond to a greater initial velocity and this is realized especially when we compare cannon with mortars, or the same mortar with different charges, when the elevation is less than 45°.

This is also one of the causes on account of which shots from howitzers with elevations less than 45° give greater probabilities than those made with greater elevations (see fig. 16a).

3rd. ΔX increases or diminishes as t diminishes or increases.

In the cases then, in which the per cent of the useful shots tends to diminish through the increase of τ, we may, by way of compension, increase t, provided the movement of the target is such that it permits the protraction of the time of the observa tion. If, for example, we always take $t = n\tau$, n being any constant whatever, $\gtreqless 1$, we will have $\Delta X = dX\sqrt{1 + \frac{2}{n^2}}$, and the probability of hitting comes out independent of the time of flight.

In practice, the assumption each time, of a different value of t, may present difficulties. Two values of t, as for example 10″ and 20″. may, however, be adopted with considerable advantage, the greater to be used when permitted by the movement of the target or when the value of τ increases beyond certain limits.

Similarly, we might discuss the value of ΔS and obtain conclusions analogous to the preceding though of less importance.

In figures 12a to 18a are shown the effects, upon the probability of the variation of ΔX and ΔS in the manner indicated in the discussion.

[Translated by Second Lieutenant F. E. HARRIS, First Artillery.]

Fig. 1a

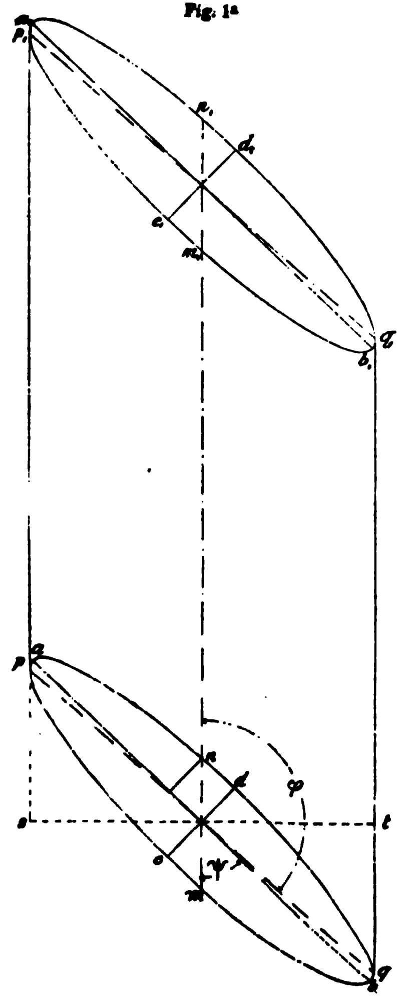


Fig. 2a

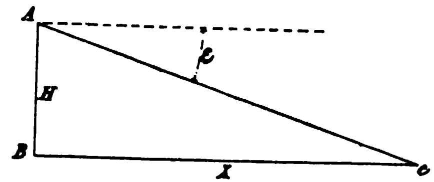


Fig. 3a

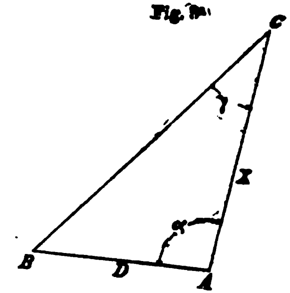


Fig. 4a

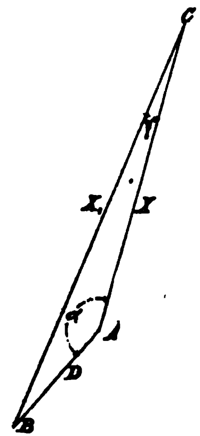
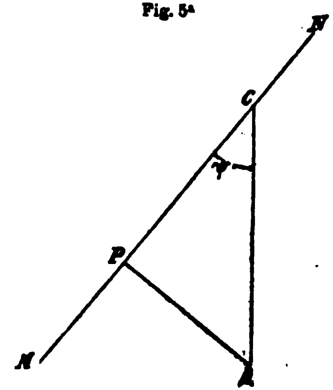


Fig. 5a



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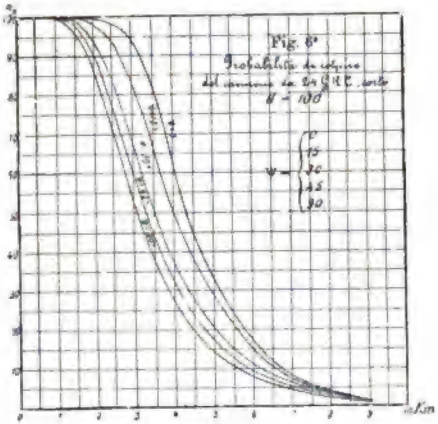


Fig. 6ª

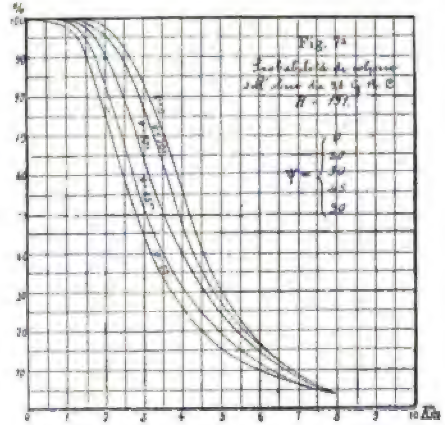


Fig. 7ª

Fig. 8ª - Cannone da 24 G R C, corto

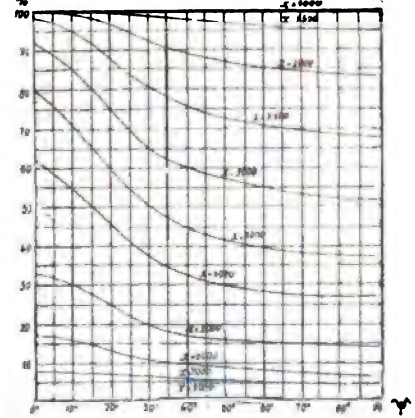
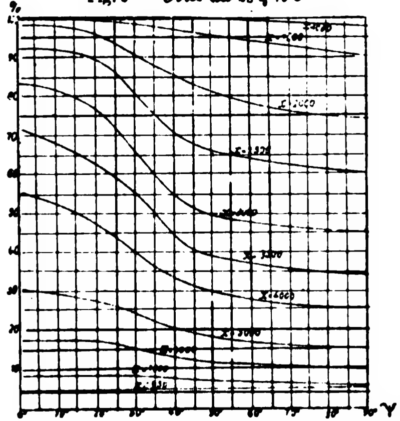


Fig. 9ª - Obice da 28 G R C



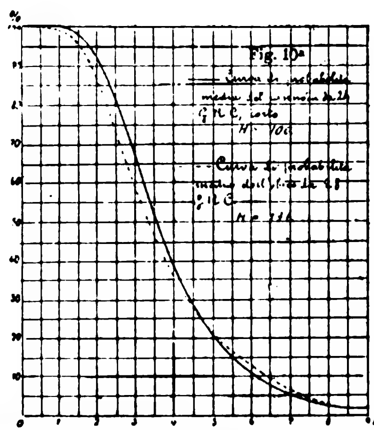
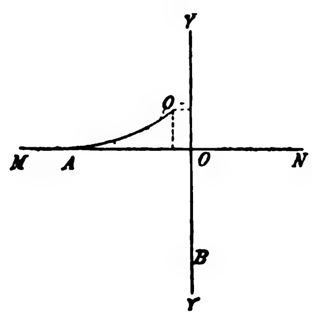


Fig. 10ª

Fig. 11ª



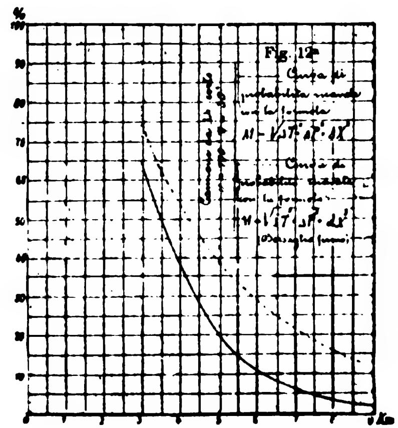


Fig. 12ª

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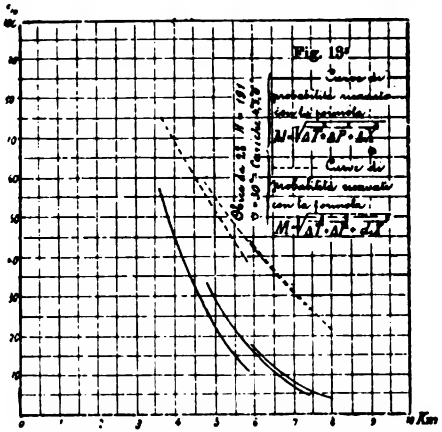

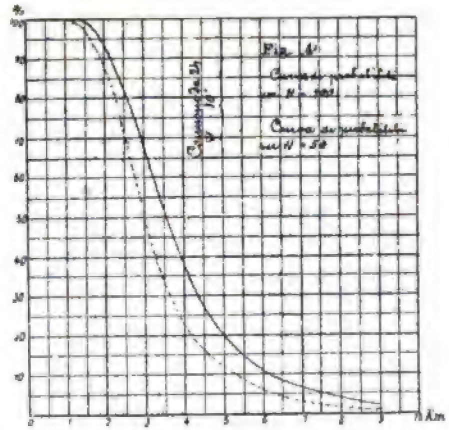

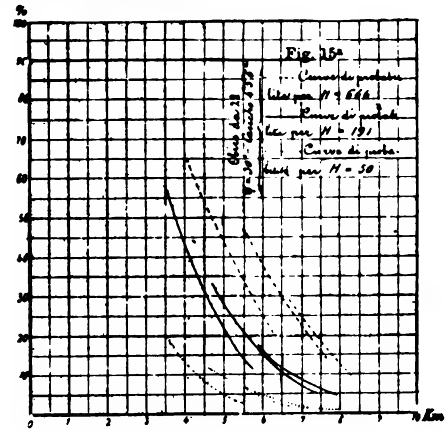

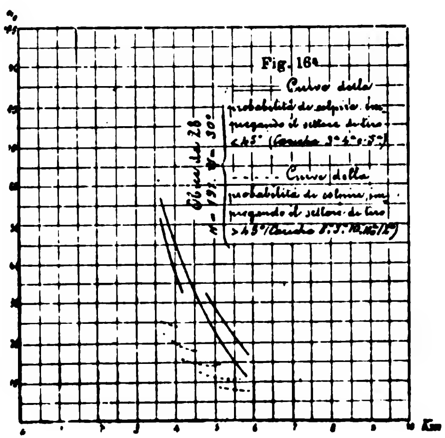

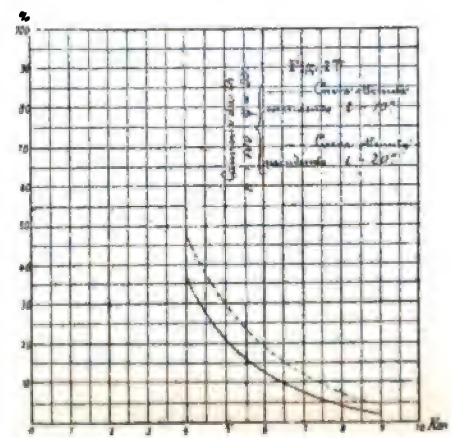

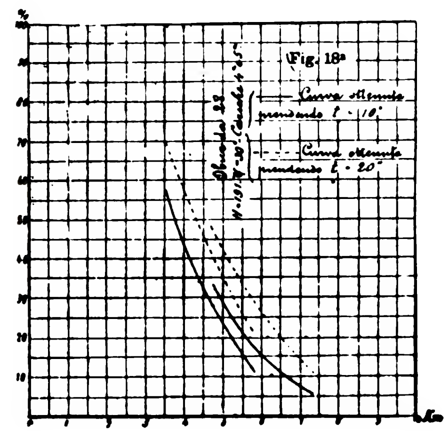

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HOWITZERS AND MORTARS FOR FIELD ARTILLERY, TO SUPPLY A NEED OF CURVED FIRE.

By Tiedemann, Major and *Abteilungs-Kommandeur* in the Posen Field Artillery Regiment, No. 29.

Jahrbücher für die deutsche Armee und Marine, November 1897.

V. GERMANY.

It was again proposed in Germany in 1885 and 1886 to introduce a short 12 cm. (4.7") cannon for use in siege warfare in places where shrapnel fired from long cannon did not possess a sufficient angle of fall. It was intended that this howitzer should also be taken into the field for use against intrenchments. But as the need of such a gun in siege warfare was not considered sufficiently demonstrated, there was a return to reduced powder charges, as we have before noted, but the results obtained were exceedingly poor. In the meantime, the military regulations of nearly all nations laid more and more stress on the spade for throwing up hasty intrenchments or even semi-permanent works; and the problem was set for the artillery to drive out intrenched infantry, or effectively cannonade them in their intrenchments. Hence the trial of diminished powder charges was revived in 1888-89; and this time comparative tests were made with the 12 cm. short cannon. This was a cast-steel piece with breech mechanism of the sliding wedge type; the length of the riflebore was 10 calibers. With the breech mechanism the piece weighed 550 kg. (1210 pounds); the service charge was 1 kg. (2.2 pounds) of gunpowder. The carriage of the piece weighed 550 kg. (1210 pounds); and with piece and accessories, 1119 kg. (2,462 pounds). The limber carrying 15 rounds (3 shell and 12 shrapnel) weighed 867 kg. (1907 pounds). Thus the entire weight, as equipped for the field, was 1986 kg. (4369 pounds), and hence was somewhat less than the German field gun. The caisson weighed 2271 kg. (5000 pounds), having 15 rounds in the limber and 36 in the body.

The shell weighed 16.27 kg. (35.8 pounds), the shrapnel with its charge in the base weighed 16.5 kg. (36.3 pounds). The shrapnel contained 557 g. (1¼ pounds) of bursting charge, and from 475 to 480 balls of hardened lead weighing 11.1 g. each.

With shrapnel the maximum range was 4300 m. with 33° elevation.

Extensive trials were made with this howitzer, using various charges, against targets in the open at all ranges; and between 2900 m. and 4300 m., the howitzers were tried in competition with field guns against concealed targets. When using reduced charges, the howitzer proved much the better as regards variation in range and observation of the shot. The firing was continued for a long time, and conducted with great pains, and the short cannon proved decidedly superior, using the reduced charges. Firing the projectiles along flat trajectories, the short cannon made a great number of hits, firing shrapnel when the point of bursting was close to the target. As the distance between point of bursting and target increased, this relation changed in favor of the field gun, as a consequence of the latter having a greater final velocity. The effect of the 12 cm. shrapnel did not extend much further than 100 m. beyond the point of bursting. The artilleries of many countries have abandoned the use of shell against living objects, and their use here in the 12 cm. short cannon was found unsatisfactory. Using both kinds of cannon for curved fire against targets protected against an angle of fall from 15° to 25°, the results were only occasionally good.

The Artillery Commission came to the following conclusion (see Müller, Entwickelung der Feldartillerie, 1870-1892): "The short 12 cm. cannon is not suitable for replacing the heavy field gun in all positions. Undoubtedly it is superior for curved fire, but it is decidedly inferior for a flat trajectory. Hence it has the character of a special gun, and a few of these guns with an army would suffice. To carry reduced charges for field guns would tend to diminish the utility of these guns for their other work."

This decision was rendered towards the end of 1888, and reference was made at the same time to the tests of high explosive shell then in progress, and it was observed that if these tests proved successful, there would be no need of introducing the 12 cm. howitzer, which otherwise might be recommended.

Germany stands alone as the only one of the powers that has finally adopted another method of reaching targets close behind parapets than that of employing mortars or howitzers. A little before the beginning of the year 1890, Germany discarded the light field gun of the horse artillery, and gave to the entire field artillery a simple field gun which met every requirement of

rapidity of fire and mobility. The inconveniences attached to using a howitzer or mortar along with a field gun of less caliber were duly weighed, and it was preferred to use the field gun fired at high angles for reaching troops protected against an angle of fall of 22° or even a greater angle.

This last object was also obtained by adopting a shell with a high explosive bursting charge. This projectile, with the same fuze as the shrapnel, scattered its 1000 fragments with so large an angle in the cone of dispersion that concealed targets could thereby be attained. A great advantage was secured in that the method of firing the shell differed little from that of firing shrapnel. Thus unity of caliber and of piece was preserved, as well as uniformity in the service of the piece and in the supply of ammunition. These are indeed real advantages, and cannot easily be overestimated.

Though the resnlts from firing this projectile under service conditions have not always been satisfactory, and unfavorable opinions of its value have at times been expressed, yet this may easily be laid to the fact that the troops must have time to become familiar with a new projectile just as with a new gun. The piece as well as the regulations for its service have undergone improvements.

The editor of *v. Loebell's Jahresberichte* for 1890 expresses himself as follows: "In our opinion the shell fired from the field gun against living objects is at least as effective as the 12 cm. shrapnel from mortars or howitzers. The reports published by Krupp and Gruson of trials with such guns leave no room for doubt on this head. Indeed the shell fired from the field gun can risk comparison with the 15 cm. shrapnel as is shown by the tests at Meppen in August, 1887. Mortars and howitzers having but a very limited application, the shell exempts us from the necessity of taking into the field cannon that serve but a very restricted purpose.

"If, however, in firing against concealed targets further requirements are made, thus, that blindages, etc., be destroyed, the howitzer or mortar then becomes indispensable, but even in such a case they also must use the high explosive shell. They will then clearly surpass the field gun firing shell; this is not due alone to the greater weight of the howitzer and mortar shell, but also to the more favorable form of its trajectory, enabling it to deliver a veritable reverse fire against the objects behind cover. However, as special guns in the field artillery have many drawbacks, we are of opinion that they should not be adopted, until

it is demonstrated that the field gun firing shell does not accomplish the purpose."

Too much penetration was at first looked for from the shell's fragments, which, though small, are yet projected with great force. As the penetration proved insufficient, however, the bursting charge was made of a less violent nature, and instead of 1000 pieces on bursting there resulted 500 of from 10 to 13 g. in weight. Better penetration was thus obtained in living targets, but much still remained to be wished for as regards inanimate objects.

If we remember how in the intrenchments of both parties in the American War of Secession, blindages of timber and plank were employed to cover the troops, it must be allowed that the shell with time fuze would not be able to destroy the slightest of these structures, with the small pieces into which it bursts. If the shell had the percussion fuze, it would indeed of itself be sufficient to break through these shelters, but it would fail because the blindages are protected against the angle of fall of the complete projectile when fired from field guns.

A force opposed to a German army would need but to construct light overhead cover in its trenches, and under this the infantry could crowd and remain there until the German infantry in attacking had approached to the critical distance, *i. e.*, to from 300 to 400 meters. Up to this time the fire of the German artillery would have failed against the shelter, and it must now cease firing for fear of hitting its own troops. The infantry of the enemy could now emerge from their cover, and undisturbed by artillery fire, open upon the attacking infantry.

In the case thus supposed howitzers or mortars would be necessary to break through the shelter; they could do this by firing shrapnel with percussion fuze, but better by shell with a high explosive charge. The shrapnel with percussion fuze would penetrate the lighter sort of cover and disable the men within on bursting. As its angle of dispersion is small, not many men would be hit, though such as were would probably receive a good many bullets. This, however, is not important, though generally speaking the object sought is, with a single shot, to render as many of the enemy as possible unable to continue to fight.

The shell would be more effective, especially when its charge of high explosive is a large one. When used with a percussion fuze, the shell would not only penetrate the shelter but would tear it up by the air compression due to its explosion ; it will disable the men within by its fragments dispersed under a large

angle, and also through the concussion in the air produce serious internal injuries. The shell, therefore, with a heavy charge of a large explosive will undoubtedly be more effective.

When it is a matter of attacking earthworks, the superiority of the shell is much more decided. The effect of shrapnel entering a parapet is very small, even when fired from a mortar or howitzer, while the shell with an interior charge of 6 kg. (13.2 pounds) of melinite (as the French 12 cm. howitzer) will tear out a large section.

Appreciating these facts, Russia and France have introduced the howitzer or mortar into their field artillery, and provided both types of projectiles, the shrapnel and the shell, the latter with a heavier and more violent interior charge.

It might seem, from the above, that shrapnel was superfluous with howitzers and mortars and might be replaced altogether by shell having a heavy charge of high explosive. This, however, is not the case, as the following considerations will show. Overhead cover will not be continuous behind intrenchments, but will occur only in a few places, since time as well as material will be lacking for constructing a considerable amount of such shelter. A comparatively small quantity of shell will be sufficient therefore to destroy these shelters or render them untenable. In spite of the great effect on the nerves of men near where it strikes, the radius of action of the shell is less than that of the shrapnel. So that the shrapnel with time fuze will unquestionably be more effective than the shell when used against troops sitting close to the interior slope, but without overhead cover. This will be especially the case when the intrenchments are not components of a fortress group, but are simply rifle pits on the battle-field or trenches to shelter supports and reserves.

The editor of *v. Loebell's Jahresberichte* for 1893 is also of opinion that shell fired from the German field gun is insufficient for attacking the lightest blindages. He is of opinion that for this purpose cannon with vertical fire, as mortars and howitzers, are requisite.

Two years later he writes: "It is more and more growing to be a general opinion, based on proving-ground tests, that shell fired from field guns are of questionable value for attacking troops behind intrenchments when the men sit close to the parapet. To reach such a target requires a precision in firing and a nicety of observation that can rarely be attained in war."

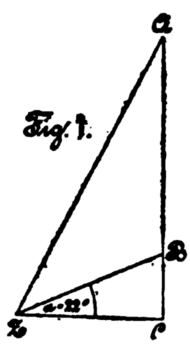
We do not entirely agree with this judgment. Precise firing and nice observation are necessary in mortar and howitzer firing

if good results are desired. Nor is it quite right to say shell are of questionable value; the most we can say is that shell is not as sure as shrapnel. In firing shell from the field gun with due care the results may prove right good, and again may be almost nil.

The reason for this is that on account of the large angle of the cone of dispersion and the flat trajectory of the field gun, only the under part of the cylinder of the projectile, making about 125 or 150 fragments, have any chance of being effective against targets close behind a parapet. The part of the projectile that is uppermost at the time of bursting as well as the pieces ricocheting from the ground will be harmless against such targets.

The angle of the cone under which the 500 or so fragments weighing 10 to 13 g. are scattered is equal to about 110°. With shrapnel the sheaf is almost evenly filled, as the final velocity of the projectile exceeds that of the bursting charge; but with the high explosive shell the cone is always hollow, the angle of the inner hollow cone being estimated at about 90°.

In regard to the effect of the shell General Rohne, in his "*Schiesslehre für die Feldartillerie,*" writes as follows: "A target close behind a shelter which protects it against an angle of fall,



α, can only be hit when the point of bursting of the projectile lies above the right line BZ (see fig. 1), which is inclined at an angle α with the horizontal. The very least cover that a parapet in the field offers is about 22°. Since the cotangent of 22° is approximately 2.5, only such projectiles can be expected to be effective the height of whose point of burst above the interior crest is more than 2½ as great as the horizontal distance between the point of burst and the crest.

The greatest angle that a fragment will have, will be equal to the sum of half the angle of the cone (55°) plus the angle of fall. At 2000 meters this sum will be about 61°, at 3000 m. about 67°, at the chief fighting ranges it will average about 64°. A projectile will have no effect whatever if its point of bursting lies above the line AZ, which is inclined at an angle equal to the steepest angle of fall of any fragment, for in this case all the pieces must pass over the target. As the cotangent of 64° is approximately 0.5, it follows that to be effective, the horizontal distance between the interior crest and point of bursting must be greater than half the difference in their vertical height.

Only projectiles bursting in the angle AZB can be effective, and these must not burst too far to the front. If they do the fragments will lose too much in velocity and will be too widely scattered.

For a light fragment (10 g.) to make a serious hit the final velocity must not fall below 150 m. (492 feet); with this velocity the heavier fragments would probably penetrate light splinter proofs. The velocity of the fragments on bursting may be estimated from 380 to 480 m. (1250 to 1575 feet); we may safely reckon, therefore, upon an unfavorably formed piece of 10 g. weight having a sufficient final velocity at 70 m. beyond the bursting point.

For the more recent type of shell, the limit for the distance beyond which the fragments become ineffective is set, not so much by the loss in final velocity as by the excessive scattering of the pieces.

It is not as easy with shell as with shrapnel to calculate the number of pieces falling on a square meter of a surface, because with the shell the sheaf is hollow and the dispersion is so great. Without any great error the distribution of the bullets from shrapnel upon a perpendicular cross section of the sheaf may be taken as uniform, for the distance of all the bullets from the point of bursting is about the same, on account of the small angle of opening. This is far from being the case with the sheaf of the exploding shell, on account of its large angle of opening; for the distance from the point of bursting of the outer bullets will then be much greater than the perpendicular distance of the cross-section plane from the bursting point and considerably greater than the distance of the inner bullets from the same point.

Since the dispersion of the fragments depends on the distance from the point of bursting, it is convenient to calculate the thickness of distribution of the pieces as though they were on the surface of a sphere. Taking the point of bursting as the center of a sphere, the sheaf will cut a zone out of the sphere, the area of whose surface at a distance r from the point of bursting will be equal to $2r^2\pi(\cos 45° - \cos 55°)$, taking 45° and 55° as the semi-angles of the exterior and the inner hollow cones. Supposing that 150 of the 500 fragments move nearer to the axis and may be neglected in dealing with concealed targets, then the thickness of distribution of the remaining pieces is expressed by:

$$\frac{350}{2r^2\pi(\cos 45° - \cos 55°)} = \frac{417}{r^2}.$$

The following table indicates the thickness of distribution:

Distance in meters from point of bursting.	Hits on 1 square meter of surface.	Distance in meters from point of bursting.	Hits on 1 square meter of surface.
2	104	22	0.9
4	26.1	24	0.7
6	11 6	26	0.6
8	6.5	28	0 5
10	4.2	30	0.5
12	2.9	32	0.4
14	2.1	34	0.35
16	1.6	36	0.3
18	1.3	38	0.3
20	1.0	40	0.3

It is easily seen that the shell will not have much effect except near the point of bursting, the more so as the targets are small and only a portion of the projectile at any rate can be expected to be effective.

To obtain a clear idea of the action of the shell, the spread of the fragments on the surface of the ground must be known for a given height of bursting. Since we take into account only such as burst near the target, the trajectory of the fragments may be considered as straight lines.

Denoting the angle of fall of the projectile at the point of bursting by α, the steepest angle of fall of any fragment by β, the horizontal distance of point of bursting in front of interior crest by S. the vertical height of point of bursting above crest by h, the expression for the spread of the fragments on the surface of the ground will be

$$2\sqrt{(\tan\beta - \tan\alpha)^2 \times S^2 - (h - S\tan\alpha)^2}.$$

This may be illustrated by an example. At 2100 m. the angle of fall α is approximately 7°, the steepest angle of fall. β, of any fragment in the cone equals 55° plus 7°, or 62°. The spread of the fragments is therefore

$$2\sqrt{(\tan 62^\circ - \tan 7^\circ)^2 \times S^2 - (h - S\tan 7^\circ)^2}$$
$$= 2\sqrt{(1.157)^2(S^2) - (h - S\tan 7^\circ)^2}.$$

The following table gives the spread of the fragments, the breadth of the space free from fragments, and the difference of the two (which will be the breadth of target that can be hit), for various horizontal and vertical distances of the point of bursting.

TABLE II.

Horizontal distance.	Spread of fragments on the ground.				Breadth of space free from fragments.				Breadth of target that can be hit.			
	for a height of											
m	3 m	6 m	9 m	12 m	3 m	6 m	9 m	12m.	3 m	6 m	9 m	12m
2	4 4	—	—	—	—	—	—	—	4.4	—	—	—
4	13.2	8.8	—	—	7.8	—	—	—	5.4	8.8	—	—
6	20.6	18.2	13.1	—	13.0	9.2	—	—	7.6	9.0	13.1	—
8	27 8	26.2	23.2	17.6	17.8	15.2	9.0	—	10.4	11.0	14.2	17.6
10	—	33.8	31.6	27.0	—	21.0	17.2	8.5	—	12.8	14.4	18.5
12	—	41.2	39.4	36.6	--	26.2	23.4	18.1	—	15.0	16.0	18.5
14	—	48.4	47.0	44.8	—	31.2	29.0	25.0	—	17.2	18.0	19.8
16	—	55.6	54.4	52.6	—	36.2	34.2	31.2	—	19.4	20.2	21.4
18	—	—	61.8	60.2	—	—	39.8	36.8	—	—	22.0	23.4
20	—	—	69.0	67.6	—	—	44.4	42.2	—	—	24.6	25.4
22	—	—	76.2	75.8	—	—	49.3	47.6	—	—	26.9	27.2
24	—	—	83.4	82.2	—	—	53.7	52.0	—	—	29.7	30.2
26	—	—	—	89.8	—	—	—	57.0	—	—	—	32.8
28	—	—	—	97.0	—	—	—	62.5	—	—	—	34.5
30	—	—	—	104.2	—	—	—	67.4	—	—	—	36.8

In the foregoing table, when the horizontal distance for point of burst becomes more than 2½ times greater than the height, no entry is made in the table, because in that case the steepest angle of fall of any fragment is less than 22°, and hence would have no effect on a concealed target.*

It is true that the dimensions assumed for the angles of the inner and outer cones (90° and 110°) are but approximations and can lay no claim to accuracy, nor is the inner space entirely free from hits, nevertheless it still holds true that even when the shell bursts comparatively close to the target, a considerable portion of the front of the target will be untouched. To obtain satisfactory results, therefore, the target must present a long front (60 meters, or more if the fire is distributed).

It also follows from the table that the depth over which a shell is effective depends in a large measure on the height of the point of bursting. For a height of 3 meters the mean effective depth is about 6 meters; for a height of 12 m., the mean effective depth is about 22 meters. If the angle of protection is increased, the effective depth is diminished in a very marked way; for an angle of protection of 45°, it is only 0.468 h. The horizontal distance for a height of bursting of 6 meters must be less than 6 (6 cot 45°), and greater than 3.2 (6 cot 62°), and the effective depth is only 2.8 m. For a height of bursting of 12 m., the

* Entry also omitted when horizontal distance is less than one-half the vertical, in accordance with what has before been shown.—Trans.

horizontal distance must be between 6.4 m. and 12 m., and the effective depth is 5.6 m. It follows therefore that up to a range of about 2500 m., more effect is to be expected from a point of bursting somewhat higher than that laid down in the firing tables.

Of course it must not be forgotten, in this connection, that by taking higher points of bursting, the distance from the target may be so increased, that the fragments will be too thinly strewn.

The next tables give an idea of the probable number of effective shots firing at targets protected against angles of fall of 22° and 37° respectively; the variation in the point of bursting is assumed to be laid down in firing tables. Shots whose distance from the normal point of bursting is more than 20 m. are not considered to be effective. Should the variation in point of bursting be greater than that laid down in the firing tables, and it always will be in battle, then for the more favorable points of bursting a slight deduction in the number of effective shots will have to be made, and for the less favorable positions, a slight increment must be made.

TABLE III.

Height of bursting. m	For a mean horizontal distance of + 40, + 30, etc., and a mean height of bursting of 2, 4, 6 meters etc., out of 100 shots at a target protected against 22°, the probable number of effective shots.									Total.
	+ 40	+ 30	+ 20	+ 10	± 0	− 10	− 20	− 30	− 40	− 50	
2	2	5	9	11	9	6	3	—	—	—	45
4	1	5	11	15	17	16	6	3	—	—	73
6	1	4	8	17	22	27	13	9	3	—	104
8	1	3	7	12	18	28	18	13	7	2	109
10	1	2	5	10	14	25	18	14	9	4	102
12	—	1	3	6	10	20	15	14	10	5	84
14	—	—	—	2	6	16	12	9	9	4	58
16	—	—	—	—	2	5	6	6	6	4	29
18	—	—	—	—	—	—	1	2	3	2	8
Total.	6	20	43	73	97	143	92	70	47	21	612

It will be seen from the above numbers that for the 22° angle of fall a mean height of bursting of 8 meters, and for the 37° angle of fall, a mean height from 10 to 12 meters gives the greatest probable number of effective shots. (The mean height of bursting at 2000 m. is given as 5.4 m. in the firing tables).

It is laid down in the firing regulations that in engagement a single range will not be adhered to, but 3 ranges taken differing by 25 m.; of these one or perhaps two is effective. For example,

TABLE IV.

Height of bursting. m	For a mean horizontal distance of + 40, + 30, etc., and a mean height of bursting of 2, 4, 6 meters etc., out of 100 shots at a target protected against 37°, the probable number of effective shots.									Total.
	+ 40	+ 30	+ 20	+ 10	± 0	− 10	− 20	− 30	− 40	− 50	
2	1	1	3	4	3	1	1	—	—	—	14
4	1	3	5	6	5	5	2	—	—	—	27
6	1	3	6	7	9	8	5	2	1	—	42
8	1	3	5	9	10	14	7	5	2	—	56
10	1	2	4	9	11	18	8	6	2	1	62
12	—	1	2	5	10	19	13	9	5	2	66
14	—	—	—	2	5	15	12	9	5	2	50
16	—	—	—	—	1	5	6	6	5	3	26
18	—	—	—	—	—	—	1	2	3	2	8
Total.	5	13	25	42	54	85	55	39	23	10	351

if 2000 meters is the desired range, then ranges of 2025, 2050 and 2075 meters will be used interchangeably, and with the fuze properly burning, and the center of impact at the target, the positions of the point of bursting will be given by the following co-ordinates measured in meters from the target (−25, 5 to 6), (±0, 5 to 6), (+25, 5 to 6).

Entering table 3 for 22° protection in cover, with these sets of co-ordinates, we obtain for the three a total of 39 effective shots out of 300 fired, or about 13%.

Using the same co-ordinates in table 4 for 37° protection, the effective shots amount to 16 in 300, or 5⅓%. This example takes the most favorable case.

If the center of impact was at −25 meters, we obtain, with the time fuze, as the positions of the mean bursting (−50, 5 to 6), (−25, 5 to 6) and (±0, 5 to 6).

In this case for the cover giving 22° protection there would be only 33 effective shots in 300 rounds, or 11%; for the cover giving 37° protection there would be 12 out of 300, or 4% effective.

The number of effective shots would be still less were the target not forked, and it became necessary to take a longer space under fire by shooting at intervals of fifty meters.

In all cases, even under the most favorable conditions, only a very small number of effective shots are to be looked for, and hence a great expenditure of ammunition is to be reckoned upon. The effect of single shots is very different as the point of bursting varies in position.

If the point of bursting lies just above the line BZ (fig. 1) only

the uppermost part of the target can be struck; the higher the point of bursting, the deeper can the target be struck, until finally the steepest fragment passes over the target.

TABLE V.

Height of bursting in meters.	Angle of fall in degrees of the steepest fragment that hits.	With a horizontal distance of 10 m. and height of bursting as in first column, the lowest point struck lies X cm. below the upper edge of a target 1 m. behind the cover, when the cover is		
		40	70	100
		cm. higher than the target.		
		x =	x =	x =
4	23¾	4	—	—
6	33½	26	—	—
8	41½	48	18	—
10	45	71	31	1
12	53	93	53	13
14	57½	115	85	35
16	60½	137	107	77
17	62	148	118	88

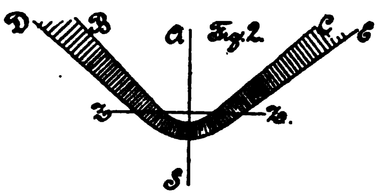
A comparatively high point of bursting has the double advantage that it increases the effective horizontal depth, as well as the vertical extent of target that may be struck. If the height of the point of bursting exceeds 17 meters for a horizontal distance to the front of 10 meters, then all the fragments will pass over the target,—even those at the steepest angle of inclination, 62°.

It is quite impossible, even approximately, to calculate the effect of a single shell, for the slightest displacement of the position of the point of bursting exercises an extraordinary influence on the result. It is not overstating the matter, therefore, to say that the effect of a single shell fired at a concealed target depends to a very large degree on chance.

Taking into view all the conditions that affect the action of shell, the chief fact regarding it is this, that appreciable effect can be expected only from those projectiles which burst at a point whose horizontal distance in front is less than 2½ times its height, and greater than one-half this height. If the shell bursts too far to the front, the effect is diminished because the fragments lose in final velocity and are too widely scattered. Hence an appreciable effect can only be expected from shell that burst close to the target, and even then a large portion of the front of the target will not be struck. A height of bursting from 8 to 12 m. corresponds to the greatest probable number of effective shots. According to table 3, horizontal distances from

-20 to $+10$ m. with heights of bursting from 8 to 12 m. give the best results.

While the bullets of shrapnel, falling on the ground, form approximately an ellipse with the bullets less thickly grouped at the center and on the edge, the fragments of a shell form a space limited by two parabolic lines, a result due to the inner hollow cone (see fig. 2). As the objective generally stands perpendicular



to the axis of the parabolas, which coincides with the line of fire, it is evident that a large portion of the front of the target will not be hit. (SA is the line of fire, Z—Z the target, S the point of bursting, the shaded space between BC and DE receives the fragments). The fragments thus form a thin ring, widening as it recedes from the point of bursting.

From this it will be seen how little is the depth of the surface that can be hit; hence the firing must be very precise, and yet in spite of this, after many rounds, much of the surface exposed may be quite untouched.

The fact of the meager results to be obtained from shell with time fuze, shown mathematically by General Rohne, is confirmed by actual tests. Of course, in firing this projectile, there is the great disadvantage that the batteries thus firing shell are no longer directed at the easier targets that are attainable as well by shrapnel, but are used against such as are difficult to cannonade effectually.

Though the losses to infantry sitting in trenches under fire from shell with time fuze, may not be so great as to drive them out, it will at all events make their situation no pleasant one, and while it continues, will prevent them from engaging in the defense.

Even with the introduction of field howitzers and mortars, shell should still be retained with the field cannon for the same purpose as before, since, however, the Better is the enemy of the Good, field howitzers or mortars should be employed when the enemy located in trenches is to be destroyed before the infantry attack closes in, provided these cannon can solve this problem. This last "provided" must be spoken so long as firing under war conditions has not clearly demonstrated a marked superiority of these curved fire cannon over the field guns for attacking concealed targets.

[Translated by Second Lieutenant *George Blakely*, Second Artillery.]

(TO BE CONCLUDED.)

SHRAPNEL FIRE FROM FIELD HOWITZERS AND MORTARS.

Discussion by MARTIN PREHN, Captain in Department of Fireworks. Former Superintendant of Proving Ground of Friedrich Krupp, Meppen.

Archiv für die Artillerie und Ingenieur-Offiziere, February, 1896.

CONCLUDED.

But, great as this concise statement shows the results of the shrapnel from howitzers and mortars to be, they are not sufficient to warrant the introduction of a special gun of which the ammunition and its packing in the limbers and ammunition wagons, and of which the service differs throughout from that of the field gun, as against the use of a single gun for both purposes. This demand for a special gun is not warranted if, with a 1.0 kg. charge, the 12 cm. howitzer fires several shots at 1980 m., with normal bursting point, and fails to hit a single rifleman at the breastworks. The service of the piece, on account of uncertainty over the charge and the difficulty about clearly making the three corrections to follow, is often confused and the efficiency of the gun can be easily placed in question. Furthermore, in the firing above, the results were obtained by an observer who stood near the target, but, if the observer remained in the battery, the firing might become so unreliable as to wholly nullify the results. This is the view held by opponents of high angle firing in field warfare.

It then follows that the advocates of high angle firing must obtain a satisfactory solution for the following problems: 1. Simplification of the service of the pieces, and, 2nd, insuring the effect of shrapnel fire from howitzers and mortars, by increased action of the separate shots.

If it were a question merely of obtaining the greatest possible angle of fall, then, unquestionably, the smallest charge, suited to the distance, would be used. The proper charge is not only determined by the effect of single shots, but is also limited by the condition of facility in the service of the piece. The greatest possible charge must also be investigated. It has been shown, in the firing of the 12 cm. howitzer above, that the charge of 1.0 kg. was as effective as the charges of 0.5 kg. and 0.6 kg.

as far as the number of hits is concerned, and therefore the velocity of 225 meters of the 12 cm. shrapnel is in this respect fully equal to velocities of 161 meters and 140 meters. Although by chance with the larger charge at the range of 1980 meters no hits were obtained on the silhouettes standing at the breastworks, yet at 1500 meters the efficiency was as great as that from the charge of 0.5 kg.

In field warfare it would not be desirable to assemble more than three charges for the howitzer, and so arrange them that the sum of the two smaller equals the larger. For the 12 cm. howitzer these will be 1.0 kg. + 0.5 kg. = 1.5 kg., or 0.9 kg. + 0.6 kg. = 1.5 kg. Between 1.0 kg. and 0.9 kg, or between the velocities of 225 m. and 210 m. there is not an important difference.

For stability of flight, both on account of the oscillation of the axis and resistance to side winds, besides the energy of rotation a certain living force of translation is necessary to preserve stability. And since, with the 15 cm. mortar, the charges of 1.0 kg. and 0.75 kg. appear equally efficient in regard to the number of hits, and the probability of striking the target seems to be somewhat in favor of the large charge at least up to 2000 m., it will readily be seen that the living force of the projectile is appropriate. This living force equals that of the 1.0 kg. charge with the 12 cm. shrapnel, since $163^2 \times 31.4$ is very nearly equal to $225^2 \times 16.5$. It must therefore be concluded that 1.0 kg. is the proper minimum limit of the charge.

In order therefore, in the use of the newest powders, to combine simplicity of service, proper accuracy, and the greatest probable number of hits, a charge which will give an initial velocity of about 225 m. must be selected for the 12 cm. field howitzer. Should the shrapnel for this howitzer be made heavier (20 kg.) and lengthened, for which there is no occasion, because the one containing 285 balls of 26 gm. weight has not shown itself inferior in the number of hits to that containing 460 balls of 16 gm. weight, the minimum velocity for the necessary living force of the present shrapnel would have to be taken at 205 m. An increase in the length of the projectile, with this velocity, would increase the oscillation of the axis; so that in this case too we would want at least 225 m.

Since in firing the 12 cm. howitzer at 1500 m., the charge of 1.0 kg. with the slight elevation of 8.8°, gives the same result as 0.5 kg. with 22.5°, it becomes a vital question whether a minimum limit of elevation or a minimum velocity should decide the

question of the choice of a charge. In the same way, in firing at 1975 m. with the 15 cm. mortar, the service charge of 1.5 kg., 210 m. initial velocity, with elevation of 12.4°, would appear superior to the smaller one of 1.0 kg., 163 m. with 22.8° elevation, but this is not the case.

In an experiment similar to the last, a comparison was made of the 1.0 kg. and 1.5 kg. charges. With the first charge, a bursting point —100 m. and 18 m. high, in 5 guns, 8 men were hit, but the whole battery received only 22 balls; with —65 m. and 8 m., 4 men were struck, the battery received 25 balls; with —65 m. and 8 m., 6 men (10 hits), in all 32 balls; as against, with the 1.5 kg. charge, with —30 m. and 1 m., only 6 balls in the battery; with both —15 and 12 m. and —25 and 10 m., only 3 balls in the battery. The following principle may be deduced: the living force with the 1.0 kg. is sufficient fðr stability of flight, yet on the other hand so small that the bursting charge checks it in a way to increase the angle of fall of the balls, while the bursting charge does not affect the velocity from the 1.5 kg. charge in the same favorable way, and the balls, on account of their high velocity, but little changed by the burst, pass ineffectively over the target.

The 12 cm. howitzer was fired with shrapnel at 3600 m., at a similarly constructed target using both the 1.5 kg. and 1.0 kg. charges, both of which failed to satisfy the expectations. The smaller required 28.3° elevation, the larger only 16°. The service charge of 1.5 kg. gave in one case, with bursting point of —35 meters and 12 m., 14 hits in 9 men, in all, 47 balls against —35 meters and 15 meters high, only 6 balls in the battery, and the results remained unsatisfactory during the firing. In the first case the axis oscillation downwards had evidently benefitted the result. The charge of 1.0 kg. gave no greater number of hits but was considered equally good. It was concluded from this that for distances between 2000 and 3600 meters, the medium charge of 1.0 kg. deserved the preference on account of simplicity, but at 3600 meters the stability of flight is not good with this charge, and the remaining living force not sufficient for lateral resistance.

In pitched battles it will be beyond the province of field guns to fire at distances of more than half a German mile at such small targets since they cannot inflict substantial damage at that range under those conditions.

It is naturally otherwise in sieges, since in this case the approaches to the position will be held under shrapnel fire from

field howitzers and mortars with medium and heaviest charges. But of still greater value will be the shrapnel fire from howitzers in sieges, in cases where this gun, on account of its mobility even when moved by hand, will be called on to reach every part of the enemies' work. The light howitzers will be so much the more fitted for this work (indeed, they will be almost indispensable) since they, among all the guns of large caliber, use a nearly or quite smokeless powder.

In this way will the maximum charge be used. In a similar manner will the field howitzers be used to keep up a slow disturbing fire with full charges over large closed field works and intrenched camps. In this manner with different pointing and different distances will the efficiency of shrapnel be brought out.

If the comparison shows that the field howitzers and mortars are in every way superior to the field guns in indirect fire, and that the latter do not give results which correspond to the highest expectations at the ordinary fighting ranges, the high angle guns, although not wholly favorable, must be acknowledged as necessary. The accuracy of these guns must become unquestionable, and for that purpose it will be almost obligatory to reduce its service to the simplest possible form by establishing a single charge for indirect shrapnel fire, or a single velocity, for which 225 m., for the 12 cm. field howitzer with 16.5 kg. weight of projectile, recommends itself; and the greatest proficiency in the service of the piece should be reached by extended exercises in firing, and observation by specially trained artillery men.

If only one charge is used this training will soon be gained. Differing from those cannon and small arms using powder producing but little smoke, in which the flash of explosion and the throwing up of sand by the projectile can be seen usually with difficulty, the clouds of smoke produced by the burst of this large shrapnel are very easy to see either when bursting in the air or on the ground at point of fall. It is naturally fitting, that the range be obtained by the commander of a gun battery, since the ammunition of the howitzer on account of its weight and small number is too expensive.

In every case the firing must be conducted so as to strike the parapet with percussion fuze—then the time fuze will be set at that division which corresponds to the time of flight taken from the range table, in order to control this part of the fuze. Then a difference in elevation of 0.4° and the same length of fuze

before taken used, unless that has shown itself as too short. If the bursting point is too low, but this side of the parapet, which can easily be seen, then 0.4 seconds should be taken from the time fuze; if the bursting point is behind the breastworks. 0.6 seconds is taken from the time fuze, but this difference in time should correspond to a difference of 75 m. in the range, as shown by the range table. From this on a slow fire is kept up without correction, unless obvious errors are shown.

The deflection allowance demands careful attention. With no wind, as many points ($\frac{1}{1000}$ range or $\frac{1}{16}$ degrees) left are taken as the elevation shows whole degrees. For a left wind, one fourth to one third of the number of points already taken are added, and for a right wind the normal deflection allowance is decreased by a similar amount—a rear wind has but little influence on the flight of the projectile, unless it be a storm; a front wind requires somewhat greater elevation, which is determined by firing. Side winds may be sufficient to double the deflection allowance or to decrease it to nothing. The rest is the same as with cannon.

It has been found by experiment with fuzes, that in howitzers and mortars they burn very regularly in proportion to the time of flight or possibly a little slowly, or the reverse that has been observed with the high velocities of cannon. With the cannon, as we well know, the fuze burns very quickly at the beginning and decreases in velocity of combustion in a ratio directly proportional to the decreasing velocity of the projectile.

Therefore the great value of as undisturbed and quiet service as can be obtained will be very readily seen. Wild firing must always be guarded against, and the actual efficiency must be counted on fully as much as the moral affect of the loud noise of the explosion.

On account of the low velocity and the circumstances connected therewith, it is recommended in practice on account of the large volume of smoke of the burst, and the long time of flight of the high angle shrapnel as compared with that of cannon projectiles, that the time of flight be measured by a watch or some instrument specially constructed to measure seconds. By firing with percussion fuze, the firing will be freed from all influence of the weather on account of the necessary connection between the time of flight and the setting of the howitzer fuze, and the battery will be oriented with regard to the burst. Good service can often be rendered to neighboring cannon in battle through such observation, if the range is taken out of the range

table corresponding to the measured time, and in this way furnish the data for them to get the distance to the target.

The second point for consideration in endeavoring to increase the efficiency of shrapnel of field howitzers and mortars in firing against covered troops is the question of increase in bursting charge and by thus increasing the cone angle of the sheaf, the bursting point can approach nearer the crest of the parapet. The torpedo shell would serve as a model for this. In regard to the efficiency of this shell, which for the present is kept with great secrecy, very little has been openly published. What is sufficient for the foregoing purpose has already been published in books, and that is its undoubted increase in cone angle of dispersion. The cone angle of the shrapnel for 12 cm. howitzer is from 16° to 20°, which is sufficient for firing with the largest charges at troops standing in the open, but if they are covered, in such a limited sheaf, too many of the balls pass over the target.

Considering, then, a torpedo shell with a cone angle of 110°, in the interior of which is a vacant space of 90°, so that only a small ring of 10° can be effective; it is not easy to see how a covered firing line can be reached with this if it is not supplied with a fuze of unheard of accuracy, and an accuracy of observation which can hardly be obtained. Most of the bursting points which can be observed naturally lie in front of the target, and the fragments will be lost in front of the target in this case, in a manner similar to that in which the shrapnel balls of a shrapnel whose bursting point is behind the target, are lost on the other side. The upper half of the sheaf is always lost to the target.

The loss of shrapnel balls behind the target will in reality be only apparent since only a single line can be covered to a high angle but never a larger body of troops, especially if they are dispersed. The conditions will be still more unfavorable if, as has already been stated, every man believes himself covered, because he simply cannot see the enemy's guns; the safe angle of covering will certainly not be measured by any one. This will generally be the case in artillery positions in the field where the bringing up of ammunition and the recoil of the guns always cause movements behind the covering. Although it is calculated that with a comparatively small number of shots, from 30 to 36, all the cannoneers of an open battery may be destroyed, it must also be remembered that the artilley rof the enemy is itself firing with a view to our destruction, and has the same chance of destroying us; it has been learned on the target range, that a single shot may strike down all the cannoneers of a single gun

together with the horses, and therefore our guns will lose their cannoneers in a similar manner to the enemy's, or they may become very much excited, so that the conditions will be entirely different from those on the target range. Besides, the torpedo shell demands much more quiet and accurate placing than the shrapnel.

Without lifting the official veil, it is concluded that a great deal is expected from the fragments of the shell, which, through the checking force of the bursting charge, will work backward in a direction contrary to the trajectory. Indeed, in the French shell, this kind of recoil efficiency is largely counted on, and also in the *obus à mitraille*.

It appears, therefore, that, if anywhere, torpedo shells will find their true place in the fire of high angle field guns. The checking force of the bursting charge would entirely overcome the small velocity of 225 m. of the 12 cm. howitzer. So loaded the weight of the shell can easily be raised to 20 kg. without thereby essentially raising the limit of weight of limber load. On account of its powerful effect, this gun has not as great necessity for speed as the cannon.

It will appear that the shrapnel is still more fitted for the high explosive without exceeding the weight of 16.5 kg. The charge could not be as large as in the shell and would therefore make the angles of dispersion somewhat smaller. The more important consequence would be that the sheaf would be less hollow than in the shell since through the pressure of the gases the force of projection will lessen the radial spread of the balls, and the useless broadening of the sheaf will therefore be lessened. In such a shrapnel, in which the forward movement is not only fully destroyed but the torn and rent base has a great backward velocity there will be a necessity of placing a limit on the forward velocity of the balls. That is very easily accomplished if a part of the balls is removed behind the fuze, say two layers, and the space so gained filled with high explosive.

In this way the balls are brought between two fires, which burst the case, and produce a very great number of large destructive fragments which fly close enough together to destroy a target. By storing the strong explosive behind the fuze the delay of the full ignition will be removed without being obliged to resort to a new construction.

This projectile would show the same superiority which is attributed to explosive shells, but its efficiency would be the greatest with low velocities out of large calibers. It is of course

understood that a combination time and percussion fuze would be used, it thus becomes much easier to regulate the firing since no loss is feared even if the target is fired over—and the fuze can always be cut to correspond to the actual time of flight.

At the beginning of such experiments it would seem advisable to use the high explosives at different strengths and not to commence with the strongest. It may be recommended to find a charge of ordinary nitro-glycerine of the smallest proportions for the bursting chamber, which will be ignited by a large charge of potassium nitrate powder lying behind the fuze, to break the base of the shrapnel. Moreover, to place the charge behind the fuze of cubic powder (Würfelpulver), might perhaps fail of efficiency on account of the slow ignition, but would considerably increase the effect. Perhaps the slight delay would be favorable to the action of percussion fuze to get a burst above the ground. These experiments must then be followed by others with stronger explosives in the chamber, avoiding the well known powerful percussion fuze always used now with the above charges of potassium-nitrate powders. The rest follows of itself.

Would the entire supply in the limber consist of high explosive shrapnel? Before more experience is had, not over one half; since those charged with black powder are to be preferred against troops in the open, with the heavier charge of 1.5 kg. in order to have greater depth of sheaf against narrow objective. A battery of six or even four howitzers will not fire all their high explosive shrapnel against a single target.

The objection may still be made to the 12 cm. howitzer on account of its clumsiness and its inability to protect itself, because of the weight of its ammunition, the number of projectiles naturally can be less only in case these weighed only one-half as much. It is also a little inconvenient not to be able to borrow from a neighboring limber since a single howitzer battery will often stand alone. But in all other respects it is as independent as a cannon battery. The mobility of the howitzer is the same, its service does not require any more men, it is furnished with a large projectile for bombarding at 6000 m., and in close combat its efficiency in the open is fully as great if not greater than the cannon battery, and when necessary the howitzer can also deliver a rapid fire.

APPENDIX.

In accordance with the wish of the editorial management, that a few remarks be added to the foregoing paper from the standpoint of field artillery, the undersigned does so the more readily

since the subject is at present one of the utmost importance, and considered by all armies as in the foreground of interest; and thereby opportunity will be taken to express a view differing from it in many points and perhaps in that way assist in clearing up this important question.

For the last ten or twelve years, ever since the more advanced methods of directing troops have demanded that the assaulting body of infantry, while waiting inactively behind cover, must be fired upon by artillery, this question has occupied the attention of thoughtful artillery officers. When it had become very clear that this object could not be attained by the ordinary means at the disposal of artillery, the most varied methods for its solution have been proposed. At the beginning, as is quite commonly the case even to-day, the difficulties of the task were very much underestimated, and, on that account, numberless experiments were tried with insufficient means, among which are to be counted the endless trials to solve the problem by means of shrapnel fired with reduced charges from field guns. I expressed my opinion very early, that the solution of the problem would not be reached by this means (vol. 94, 1887. "What basis is there for the introduction of small charges in field artillery?").

At that time in harmony with Major Leydecker, whose views on the expediency of small charges I opposed, the adoption of a field high angle gun for shrapnel was proposed, based upon reasons entirely coincident with those given in the above discussion.

Very soon afterward the means were discovered of firing without danger projectiles charged with high explosives from cannon, and as early as the spring of 1888 I showed that this projectile possibly offered a solution of the question. ("Another discussion of small charges for field artillery." Vol. 95, 1888). The question at that time was: shall the field artillery adopt a special gun, or a special projectile, for reaching troops close behind cover; shall the field howitzer or torpedo shell be adopted; it being understood of course the field howitzer with shrapnel, since the idea of making the field howitzer sufficiently strong to withstand the bursting of a torpedo shell in the bore (and this demand was made), seemed to be excluded from the beginning. The decision was made in favor of the lesser evil, the torpedo shell, since there was no necessity of reducing the charge.

This hasty decision did not conclusively settle the question; between the advocates of the torpedo shell on the one side, and those of the field howitzer on the other, there was no peace, only

a suspension of hostilities. There were fanatic admirers of the torpedo shell, who in their infatuation had accepted it as the best and only projectile for field artillery (see *Militär-Wochenblatt*, No. 1, 1893; "Simplification of ammunition supply for field guns," which paper treats of this error), and there were adherents of the field howitzer who attributed to this gun not only the ability to fight against covered troops but also to take part with success in the artillery duel. (See *Militär-Wochenblatt* No. 110, 1891: "The field gun of the future, and the field gun for coming requirements"). The author of the present paper belonged to the last class.

My belief is that one must guard against setting too high expectations on the field howitzer; there is one objection which it is almost if not quite impossible to overcome. It ought to be effective in the first place against covered troops, and this supposes a highly curved trajectory with wide angles of opening of the sheaf. It ought at the same time to give good efficiency against troops standing in the open, but these can only be reached by a flat trajectory, and narrow sheaf. The author of the above mentioned article has also very accurately noted this fact, and in order to overcome the difficulty he would provide the gun with two kinds of ammunition; namely a shrapnel against open targets with greatest possible charge ($V_0 = 290$ m.) and narrow opening of the sheaf (base charged shrapnel), and a second shrapnel against covered targets with smaller charge ($V_0 = 140$ m. to 225 m.) and wide opening of the sheaf (shrapnel with base and point chambers, both filled with high explosive). Doubtless this is the only way of satisfactorily overcoming the difficulty.

But the question here arises, whether, uniformity having been once abandoned, it would not be expedient to employ the present field guns with decreased charges and a projectile of somewhat wider opening of the sheaf, but not so wide as that of the torpedo shell c/88.

The author of the foregoing discussion, who has had a very great experience, since there is perhaps no officer in the German Empire who has conducted so many experiments, considers this solution impossible because the large chambers of the long cannon cause the small charges to fly apart, thus preventing uniform combustion from shot to shot (p. 165).

Doubtless this proposition is supported by an exceptionally extensive observation, but, nevertheless it is my opinion that this is not necessarily the case. Since the shots to be fired with reduced charges are packed in special wagons, there is no reason

why with them there should not also be a specially quick burning powder to equalize the velocities from these large chambers. Should this not be successful what hinders us from making these large chambers smaller? The means for doing this are not lacking, such as lengthening the projectile, or if that fails, as is easily conceivable, to meet the requirements by the insertion of a pasteboard or similar cylinder between the projectile and the charge as has been done by the French in their short 120 mm. cannon. I think that without doubt success would be achieved by this means; not that I believe the efficiency of the cannon so fired would be equal to that of the howitzer against covered targets, but in the sense that its efficiency would be naturally increased over what is now attained or attainable by present methods.

As no one can serve two masters, so every gun, which serves two so widely different purposes, will be indifferently fitted for both, or efficient only for one. In this way the field gun which is very efficient against open targets has only a moderate effect on covered targets and conversely the field howitzer which has a good efficiency against covered targets, in its work against open targets, will lack much of accomplishing the required result. But too high expectation must not be placed on the efficiency of the field howitzer against covered targets or otherwise many disagreeable disappointments may be experienced.

What has been said of its efficiency with shrapnel against such targets can now give no basis upon which may be judged its actual work. These results do not equal by a great deal those which are obtained under similar circumstances by the field gun with torpedo shells; it being understood that the basis of comparison is not the number of hits per projectile, but per unit of weight of projectile, a means of comparison to which there can be no objection.

In reference to the numbers given in the tables above it must not be overlooked that:

1. The targets were often covered only against very small angles of fall, and those that were covered against an angle of fall of 22° showed very few hits. The targets, erected for field artillery on the target range, and fired at with torpedo shells, are covered under angles of fall of from 22° to 36°.

2. The corrections were based upon observations made at the targets, and under such circumstances torpedo shell from field guns are much more efficient than shrapnel from howitzers.

Whenever observation is easy, the firing is successful, and the results accomplished under these circumstances by the torpedo

shell of the field gun are so entirely satisfactory, there is no necessity of striving for greater efficiency. As long as the old works constructed on the target range for the use of the foot artillery were utilized for the erection of the targets, the work of the torpedo shell was so far preferable that at once many officers were so taken by it that they desired it as the only projectile.

Since that time this high covering has disappeared and the targets have become of field pattern, and the expected efficiency is lacking, and indeed for that very reason, since the observation became so difficult that the firing very often failed.

The probability that the difficulty of observation was due to the target rather than the projectile is a thousand to one, and the same result would be obtained in using high angle guns. It is not because the torpedo shell demands an accurate firing but because the target is so small and so well covered. The introduction of a high angle gun would not change these conditions in the least. An efficient result can be expected with the howitzer only by using a projectile with very wide opening of sheaf, at all events I am of opinion that the construction of the projectile has at least equal importance with the curve of the trajectory. Where both these factors combine with surrounding circumstances it can be readily understood that there is a more favorable prospect for a satisfactory result.

There is no difference of opinion that if the field howitzer is to be introduced in general use, it should be represented only in small numbers.

The only justification for their introduction would be that their efficiency is so superior to that of cannon that they cannot be replaced by several of the latter firing at the same target.

My opinion of this weighty question may be briefly stated as follows:

1. The more advanced methods of directing troops, if properly followed, demand that men close behind covering, who do not themselves take part in the fighting, should be effectively reached by field artillery and therefore there must be sought an effective means to reach them by firing torpedo shells from field guns with service charges.

2. A high angle gun that fires only shrapnel with narrow opening of sheaf (about 30°) is no such means.

3. As a means for attaining this result are offered

a. A torpedo shell or shrapnel out of field guns with reduced

charges, if they have a cone angle of from 80° to 90° and the cone angle is less hollow than in the present torpedo shell.

b. A field howitzer with projectiles which have a wide opening of cone angle of from 60° to 70°, like those proposed in the foregoing article.

c. If neither of these two means bring about a substantial increase of efficiency, there remains the method adopted by the French, their walled torpedo shells with very large charges, perhaps the last resort. Dependence is placed in this case, not on the work of the fragments but on the atmospheric pressure due to detonation of the projectile. It is a desperate means and it can therefore be easily understood that no other country has adopted it. (See *Revue d'Artillerie*, February, 1896).

All these ways should be simultaneously introduced, according to my opinion, so that without loss of time, the means accomplishing the greatest result could be ascertained.

Now only a few details, which only slightly touch upon the main question but which are of sufficient importance to be elucidated, so that false conclusions will not be drawn from the above discussion.

In my opinion the bursting of the shrapnel is not properly described in the foregoing. On page 167 it is stated that the gas produced by the burning of the bursting charge exerts a pressure on the base of the projectile which results in a retardation of motion of the whole projectile.

This is entirely impossible and is caused by an easily comprehended optical illusion. The gases not only exert a pressure on the base of the projectile but also on the diaphragm and through this on the contained balls. By means of this pressure the body of the shrapnel, in case this remains whole, receives a velocity to the rear, while the balls have received a similar one to the front. The velocity imparted depends on the work performed by the bursting charge and the weight of the mass moved. The relations are similar to those which exist when a gun is fired, the projectile goes in one direction and the gun in the opposite direction.

Representing the weight of the body by B, that of the balls, diaphragm and point together by F, and by V_B and V_F their respective velocities, then the products of the two masses and their velocities must be equal, or, $BV_B = FV_F$.

If the projectile has at the bursting point the velocity V, after the burst the body will have the velocity $V - V_B$, and the balls $V + V_F$.

Now if the weight of the body is small in comparison to that of the balls, etc., as is the case in properly constructed shrapnel, the value of V_B may become quite large in proportion to V, which is always small in high angle firing. Therefore the reduction of the remaining velocity in the body of the shrapnel caused by the bursting charge may be very great, in fact it may entirely overcome that velocity and the body of the shrapnel receive a motion to the rear. In this way may be explained all the observed phenomena cited in this treatise; only the body of the shrapnel was confused with the whole shrapnel by the observer. The parts which fly forward do not form a single mass, and therefore are not seen by the observer; but they always receive an increase in velocity whenever the bursting charge is placed in rear of the balls. That a force in the projectile can destroy the work stored up in it by means of the charge in the gun, or can change it in ever so slight a degree, is contrary to all laws of mechanics. Moreover, the fact that a shrapnel held firmly in position by an abutment will, if exploded, give greater velocity to the balls through the bursting charge, than one exploded when hanging free, is also in full accord with what has already been said; to the weight of the body of the projectile is added the weight of the abutment which may be assumed infinitely great, and the bursting charge, which in the case of the suspended shrapnel performs work on both the body and the balls, in this case performs no work on the body of the shell. The total work of the bursting charge being approximately the same in both cases, the balls will therefore receive a greater velocity.

On page 339 there is a view expressed which ought not to go uncontradicted, especially since it is very widely disseminated. It is that the firing at covered targets by torpedo shells out of straight trajectory guns requires fuzes of unheard of accuracy. This is a view which has grown up only on target ranges which are not fixed according to war conditions, but fitted up for the particular object in view, and where observations are made at the targets. Now, where the position of the *mean* bursting point can be regulated entirely at will, a small scattering of the balls is naturally very desirable.

But the case is entirely different in actual battle, where the observations are unreliable, and where, even if observation were reliable, no fine corrections could be made. In this case the smallest error in the location of the mean bursting point would entirely ruin the firing, if the scattering of the balls was very small; whereas, by the scattering of the balls some effective

shots would be obtained even though the position of mean bursting point was not absolutely favorable. The great accuracy of the gun does not always guarantee the greatest probability of hitting. So that one can almost say the scattering of the fuze is much too small, since it is well known that the firing rules require that the firing shall be conducted at three ranges differing by 50 m. Of course in this way the scattering in depth only is affected, in width it would remain the same.

Notwithstanding the fact that my views differ from those of the author of the above discussion in many points, I am of the opinion that in publishing it, he has done a valuable service toward the development of this important question. I believe that the proposition to provide shrapnel with chambers both in the base and point, is especially worthy of attention.

ROHNE,

Major General, Commander of the 8th Field Artillery Brigade.

[Translated by First Lieutenant E. S. BENTON, 1st Artillery].

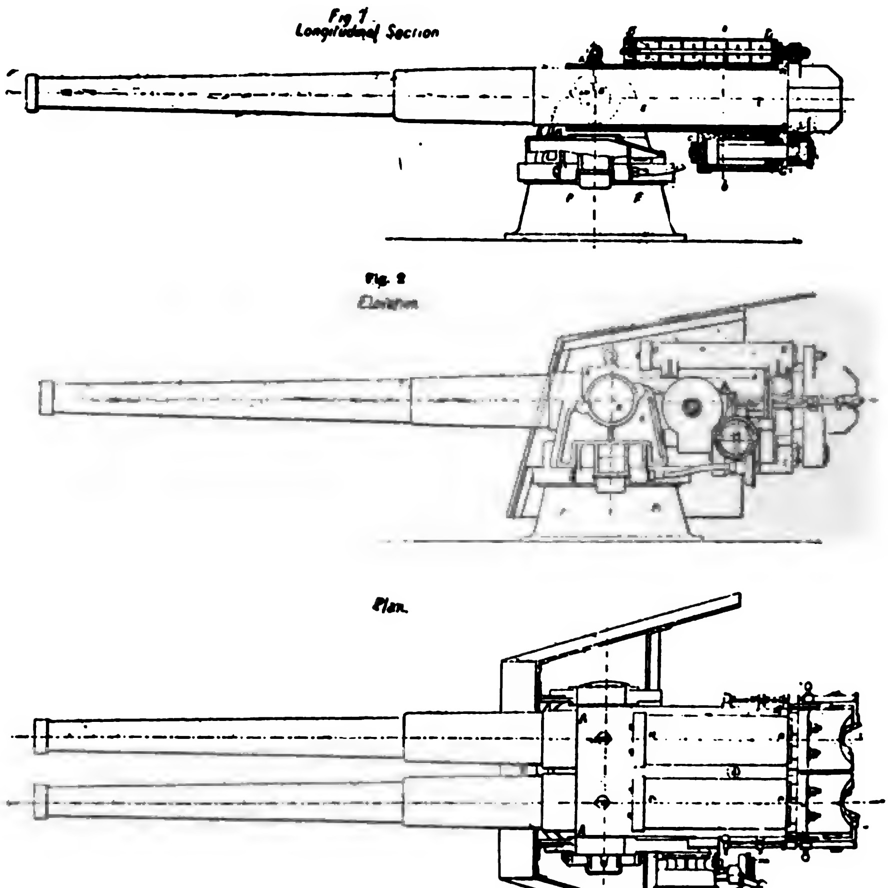


Fig. 3—SCHNEIDER-CANET DOUBLE-FIRE MOUNTING

PROFESSIONAL NOTES.

ARTILLERY MATERIAL.

a. Guns and Carriages.

Double Fire Schneider-Canet Mounting For Quick Fire.

The double fire Schneider-Canet mounting solves the problem of combining in the hands of a single gunner the chief organs of two quick-firing guns; that is the firing and pointing, including elevating and training. It allows the two pieces to be fired simultaneously in succession, and to be directed on the same point, and thus it obtains great results. With these special characteristics it combines great simplicity in working with a minimum weight and bulk.

The mounting comprises the following parts:—(1) The cradle; (2) the saddle; (3) the pedestal. The cradle consists of a double sleeve made of a single piece of steel, in which the guns recoil independently of each other (see A A, in Figures). This double sleeve carries in the front position, the trunnions B, and in the lower part the two brake cylinders C C of the guns. Above are placed the recuperator springs D D D D, independent of the brakes, securing the return into the firing position at all angles of elevation. On the left side is fixed the slotted arc for elevation.

The guns are furnished at the posterior end with the rings by which they are attached to the pistons of the brakes and the recuperators. The saddle E E consists of two checks, which take the trunnions of the sleeves, and it is carried downwards in the form of a central conical pivot which fits into a pedestal in a vertical socket. A cast arm on the left cheek supports the pointing arrangements—see Figures. The pedestal T T, also of conical form, is fixed on the deck, and supports the whole of the fittings for training and elevating—see Figure. The brakes C C are of the Schneider-Canet system, and constructed to give uniform pressure, and consequently to give the minimum of strain on the various parts. The recuperators are formed each of two cylinders of springs, and are independent of the brakes. The elevation of the sleeve carrying the two guns is put in action by a spring placed near the hand of the gun captain by means of bevelled wheels and endless screw gear—see Figure. Special arrangements to reduce friction to a minimum assure the complete and easy command of the mechanism by a single man. The gear for orizontal movement or training works in the same conditions as to rapidity and ease, the captain presses a spring which acts by bevelled wheels on an endless screw which moves on a toothed circle fixed on the upper part of the pedestal. The gun captain has equally under his control the handles for firing the two guns.

To sum up, the chief advantages offered by the Schneider-Canet mounting for double-fire, delivered with special speed, are the following: - (1) The combination of two guns on the same sleeve mounting, which permits the reduction of the distance between their axes to a minimum, and consequently to decrease in great proportion the couple acting laterally on the fittings when a single piece is fired. (2) Minimum weight. (3) Reduced encumbrance on the deck. (4) Complete solidarity of the two pieces, of which the direction and firing depend on a single man, having to his hand all the gear for working,

and who can consequently follow the change in position of a moving object. (5) Rapidity of fire. (6) Great ease of working due to reduction of friction. (7) Minimum strain of parts. (8) Reduction in the number of the detachment needed to work the two pieces. (9) Facility of concentrating the fire of both guns on the same spot, and of thus obtaining great effect. The advantages. it is urged, allow a result to be obtained which is at least double that of those which are got by pieces detached, and at a greater or less interval. This type of carriage is said to be applicable to pieces of all calibers.

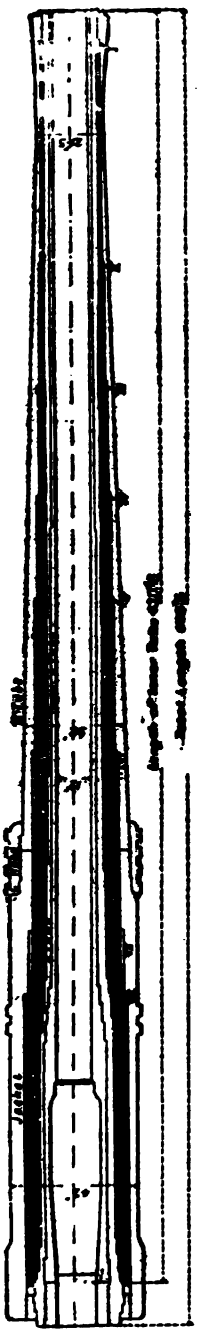
—*The Engineer*, March 4, 1898.

The Construction of Modern Wirewound Ordnance.

No. III.

We are glad to be able to put before our readers a longitudinal section of the latest existing 12 in. wire guns, Mark VIII., as they are known officially. A new gun of increased power is, we understand, under discussion. It probably will not greatly vary from that shown in the figure, except in increased length and strength in certain parts. The enormous length of the chase hoop to which we called attention in a previous part can now be appreciated. It will be noticed, too, that the wired portion extends right up to the muzzle, and perhaps it may be as well roughly to indicate some of the reasons which caused the War-office to adopt this pattern. To the difficulties of securing steel of equal quality throughout such a large forging as that required for the chase hoop, and the subsequent difficulties of manufacture, we have already alluded. Cogent reasons for deciding to entertain the risk and the increased cost were therefore necessary. The main argument in favor of wiring to the muzzle is that nearly all guns which have failed have done so in front of the trunnions or rings, probably because it is in this region that premature explosion of shells occur. The first of such explosions may not destroy the gun, but it will burst under subsequent accidents. By wire winding, both the chances of explosion and the damage resulting from explosion are lessened. Another reason is founded on certain experiments made at Woolwich some years ago to ascertain the effect of firing at the chase hoops of a 10 in. gun. It will probably astonish some readers to know that the bullet from a 1 in. Nordenfeldt caused the steel to crack in various direction almost like glass. The reason of this remarkable weakness is ascribable to a variety of causes. The thinness of the metal and the probable increased severity of the initial stresses, as well as the after effects produced by frequent firing, tend to harden it. In moderate-sized and small guns, for obvious reasons, it is unnecessary to take precautions against such an occurance. In the first place, the target presented is very small, and the radius of curvature is very sharp, so that a shot is seldom likely to strike dead true. In the 12 in. guns the smallest diameter is 21½ in., an appreciably large target for small quick-fire guns, and it is therefore necessary to take all possible precautions to reduce their suffering on being struck. Now the chase hoop in a wire gun has very little to do with the transverse stresses. These are nearly all taken up by the wire, and, consequently, the chase hoop does not have to be contracted so tightly on to the gun as when the solid method of construction is followed, and it is therefore less likely to fracture when struck. Moreover, supposing it was actually pierced by a small shot and the wire cut, the strength of the gun would not be appreciably lessened by so small a hole.

Returning for a moment to the subject of forgings, some additional examples of hydraulic presses are given. These are very representative types,



made by Messrs. Fielding and Platt. The special feature of presses constructed by this firm is the very simple and effective system of valves, the invention of Mr. John Fielding, whereby power is economised to the fullest possible extent, whilst the working is much simplified. This systemis applicable equally to presses worked by direct pumping, accumulator, or steam intensifier. The arrangement is such that pressure-water cannot be admitted to the press cylinder except for the actual pressing operation, even by the carelessness or want of skill of the attendant. There is, therefore, no necessity for limiting the length of stroke, so that ample clearance may be given to allow of free manipulation of the forging. The effort required on the part of the attendant is very slight, as only one small valve has to be handworked, all other valves belonging to the press and pumping engines or accumulator are automatic in their action.

The engines are very massively proportioned, and are automatically controlled by the action of the press valves. When the press is at rest the engines are kept slowly moving, so as to keep the cylinder warm and free from condensed water.

Presses worked by direct pumping are proportioned for a maximum pressure of three tons per square inch, steel cylinders lined with gun-metal and packed by cup leathers being used. For working the lifting cylinders a pressure of 1500 is employed. All packings, where possible, are of hemp, which Messrs. Fielding and Platt find by experience to be preferable, on account of the ease of removal. They regularly use this kind of packing up to pressures of two tons per square inch, with excellent results.

Steel is, of course, mainly used in the construction of these presses, cast iron being only used where its compressive strength makes it suitable, as in anvil block, distance pieces, etc. In addition to these heavier presses, Messrs. Fielding and Platt make quick-speed presses of smaller powers for general smiths use, stamping. etc., which hardly, however, belong to that part of the subject of hydraulic forging to which the present article refers.

A pair of horizontal direct-acting steam pumping engines, made by the Southgate Engineering Company, Limited, which have been specially designed and constructed for a foreign Government for working a 3000-ton hydraulic forging press for ordnance work, are what called the main pumping engines, and pump direct into the hydraulic cylinder of forging press. In addition to these there are the supplementary pumping engines, which pump through an accumulator at a pressure of 1500 lb. per square inch,

and are used for lifting the ram of the forging press. The main pumping engines work at a hydraulic pressure of 3½ tons per square inch. There are two steam cylinders, 32 in. diameter and 36 in. stroke, driving four pumps of 4 in. diameter, connected direct to the piston-rods of the steam engines. The bed plates of the steam engines are bolted to the end of the bed plates of the hydraulic pumps. The casing or chambers are of forged mild steel, made by Messrs. Firth and Sons, Sheffield, and the cylinders and valve boxes are drilled and finished from the solid steel forgings. The pipes connecting to the hydraulic forging press are connected directly to the ram of the forging press. They are controlled by a hydraulic valve, which is worked inside the forging shop. The steam cylinders are worked at a pressure of 150 lb. per square inch.

The following list of the average weights of the forgings—all forged hollow—of the principal parts marked upon the drawing of the 12 in. gun are of interest:—

Inner A tube or liner	7.9	tons.
A tube	13.6	"
Jacket	16.5	"
C hoop or connecting ring	2.6	"
B tube, muzzle jacket, or chase hoop	13.8	"
Breech fittings complete	1.1	"
The total weight of forgings, all forged hollow	55¼	"
The total weight of wire	12	"
Total of rough material in gun	67¼	"
The finished weight of gun is	46	"
Difference between weight of material rough, and polished gun	21¼	"

As no appreciable amount is removed from the wire, this figure means that 21¼ tons, or nearly half its weight of material—46¼ per cent.—has to be removed from the forgings, and is lost in the construction of a 12 in. gun.

After forging, the hoop or barrel is "first" annealed; that is to say, it is raised to an indefinite high temperature, and allowed to cool slowly. The object of this operation is, of course, to remove the stresses set up in the material by forging. After this a long forging usually needs straightening, an operation usually performed under the hydraulic press; it is then rough machined all over, both inside and out, and rings and discs are cut off the ends, cut and turned down to suitable dimensions, and tested for elongation and breaking. This is technically known as the "soft" test. On the next two operations the working strength, as we may call it, of the steel depends. The forging is first heated to a temperature between 1450 deg. Fah. and 1600 deg. Fah., depending upon the opinion of the steel expert as decided from the first test, and from the furnace is lowered directly into a well of rape oil, where it remains till cool, the time required varying between six and twelve hours, depending on the size of the piece. As one large oil tank is generally deemed sufficient in a factory, arrangements are made, as far as possible, to work "shifts about;" that is to say, the day gang of workmen put a casting into the oil, which will be cool by the evening, and the tank ready for the night gang, their forging in turn being cool by morning. The tank is surrounded by a water jacket. It is, we believe, invariably sunk into the ground to a depth of between 40 ft. and 50 ft., and measures between 6 ft. and 7 ft. internal diameter. Above it, of course, on a gantry, some means of moving the huge forging from the furnace to a position for lowering are provided. The mouth of the well is covered by iron doors, which are closed as soon as the first evolution of gas has burnt. The lowering of so large a mass of red-

hot steel as is represented by the greater forgings for the big guns into a comparatively small weight of fairly inflammable oil is not wholly unattended by danger; but, on the whole, few accidents have occurred, and it is only at the instant that the metal is being rapidly lowered into the oil that any flaring occurs. As soon as it is right in the doors are closed, and the oil boils away quietly. It may, however, be remarked that small hollow forging call for more care, and are more liable to produce accidents, than large forgings. This is due to the narrow bore of the small forgings, which is too contracted to allow the first bubbles of gas to escape. The consequence is that, if proper precautions are not taken, a quantity of flaming oil is shot up vertically out of the tube.

Two methods of heating and lowering the forgings into the oil tank are followed. In the first the tube or forging is heated on a steel frame truck with fire brick floor in a horizontal furnace. The truck is drawn out, and chains rapidly run through the tube and attached to a cross bar at the back. The front ends of the chains are attached to a larger chain, which passes over a pulley immediately over the oil well, and is commanded by a powerful hydraulic crane. The crane being put in action, the tube is first raised up into a nearly vertical position, and then allowed to swing gently, being controlled by chains attached to it, over the well and immediately rapidly lowered. The other method is to heat the forging in a vertical furnace provided with doors in its side. The furnace is entirely or partly above ground, the well is below ground, as we have said. It is, therefore, only necessary to open the doors of the furnace and lift the forgings a short distance, and traverse it till over the well, and then lower it. The second method seems to have many advantages over the first, but in actual practice the gain is not so great as would be expected. The time for the whole operation is nearly the same in both cases, and the inconvenience of luting the long door of the vertical furnace has to be considered. By partly sinking the furnace this trouble is reduced, and although we know of no case in practice, we see no reason why the whole length of the furnace should not be below ground, in which case the necessity for doors would be entirely removed. It is, however, doubtful if even by this means much time woule be saved, as the crane would have to make a long lift. The advocates of the horizontal furnace also contend that the forging is more evenly heated, a point of the utmost importance; but the vertical men refuse to acknowledge that as a fact, and make retort that in the horizontal system the forgings are always bent in raising them from the horizontal to the vertical position, to which the advocates of this system reply that a forging always bends when you heat it and cool it suddenly, no matter how it may be supported.

The vertical system is, however, rapidly gaining in favor, and is used by several makers on the Continent, and at Woolwich and elsewhere in this country. The furnace proper is made of boiler plate lined throughout with firebrick. It is placed within a second large cylinder of cast-iron, which is sunk in the ground. A crane is placed over the furnace in such a position that it has convenient command of both the oil well and furnace. The well is placed in close proximity to the furnace, and is almost entirely below ground. The large part of the furnace which is above ground is closed by doors, the joints of which are luted when the furnace is in service. The top is closed by a dished plate, lined also with firebrick, which can be run to one side on rails when it is required to raise the hot forging.

The furnace is heated by gas supplied from a Dowson's gas producer. The gas passes by pipes to a belt, which has a number of openings like the air belt. As soon as this gas will ignite and burn freely, the gas may be admitted to the furnace, and some lighted oily waste dropped down through the sight holes in the cover. The air is then gradually admitted, and the heat increased as required until the flame extends the whole height of the furnace, or as far up as required. An air pipe supplies air from a blower for assisting ventilation and keeping the pit cool. Ladders are provided for descending the pit. The temperature is regulated by the air slides, so as to enable a long tube to be uniformly heated throughout its length.

The effect of heating the steel, and thus cooling it rapidly, is, of course, considerably to increase its strength but to decrease its ductility. At the same time internal stresses are set up. With a view to keeping these as low as possible, consistently with the success of the operation, rape oil is used for cooling instead of water, its heat conductivity being lower, and the effect on the metal consequently neither so sudden or severe. The steel is nevertheless in a state unfit for use. To give it the necessary toughness, therefore, the forging has to be tempered. For some unknown reasons the process is called "annealing," or, for exactness, "second annealing," to distinguish it from the first similar operation after forging. The forgings are usually heated to about 900 degrees Fahrenheit to 1100 degrees, again depending on the first test, in closed furnaces, and are then allowed to cool out very slowly. At Woolwich this operation is also performed in a vertical gas heated furnace.

This furnace was designed from the suggestions of Mr. C. Turton, the manager of the Woolwich gunshops. No better method of heating than this could be desired. The forgings are enclosed in an oven to which the actual flame never penetrates, but which gradually and regularly increases in temperature. The steel is thus subjected to no uneven strains, and distortion does not ever occur.

In this country pyrometers for measuring the temperature in the furnaces are rarely employed, as an experienced operator is able to judge from the appearance of the forging what its temperature is within a sufficiently accurate limit. Only in the testing laboratory, as afterwards to be explained, an accurate pyrometer is used, so that the conditions of the test may be known absolutely.

—*The Engineer*, February 4, 1898.

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c. Powder and Explosives.

A Smokeless Powder Press.

The press shown in our illustration is one of several types of similar machines designed for the manufacture of smokeless powder, and made by the Watson-Stillman Company, of this city.

Smokeless powder is manufactured into sticks of the caliber needed and cut off the right length to fill cartridges. These sticks contain from one to six holes for the entire length, according to the kind of powder that is used, and these presses are designed to take the powder in a plastic state and press it into sticks for use, and, in shop parlance, are called "squirting presses."

This particular press is an eight cylinder affair, made for the pressing of powder for small calibers. Each of the plungers is 2½ inches in diameter, with a stroke of 19½ inches. The pressure is 3,000 pounds to the square inch,

exerting a total pressure of 12 tons on the material in the cylinders, forcing the same through the die at the bottom into a proper receptacle.

As will be seen the eight cylinders are controlled by one large multi-spindle valve operated by a lever, and each clylinder is provided, in the valve casing, with a separate controlling valve, throttling and governing its speed according to the condition of the materials, or cutting the cylinder out altogether.

Smokeless powder is rather precarious stuff to handle and will not stand very much abuse. This press provides for all emergencies that may arise. The powder may explode in one of these presses without very much damage; it automatically throws up the hydraulic ram.

In each head there is located a vacuum valve and an air valve. The latter is open except when closed by actual contact with material under the ram. If any air gets between the ram and powder, compression heats it and causes an explosion. On the other hand, the too sudden withdrawal of the ram will cause an explosion. Therefore a vacuum valve is provided.

On the sides of the cylinders, top and bottom, will be noticed cast lugs. They are for hooking in bales or handles for carrying the cylinders. The powder is put into the cylinder in a plastic state and kept there until pressed out as needed, the cylinders being taken to the press for this purpose. On the left hand of the table will be seen a die and die holder that go into the heavy plate under the cylinders.

This machine is shown as a specimen of the work now going on in our machine shops on account of the activity of the War and Navy Departments.

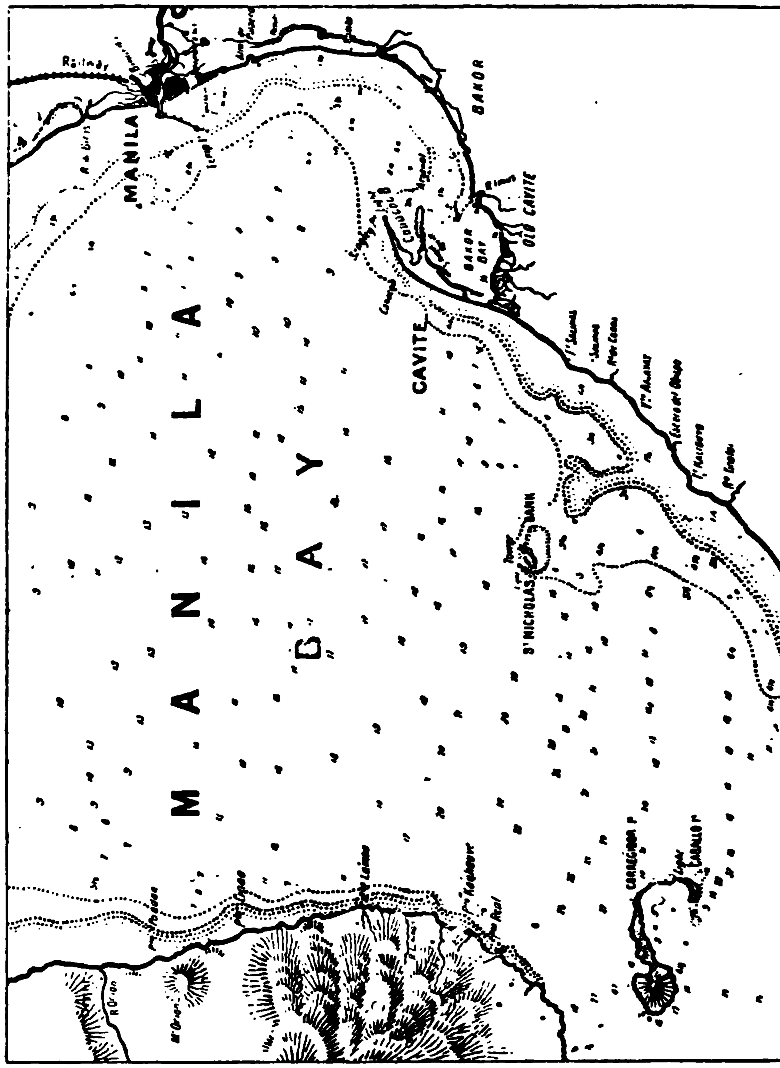
—*American Machinist*, May 5, 1898.

TACTICS, STRATEGY AND MILITARY HISTORY.

The Hispanc-American Struggle.

The prospect of an engagement between the squadrons of the United States and of Spain in the Philippines had hardly raised expectations before these were gratified. The result has been disastrous to the Spaniards, and in a measure it is to be feared from the accounts we have received that this is due partly to a lack of energy and foresight by the authorities at home and partly

to want of skill by those engaged in the conduct of operations. Not only were the defences quite inadequate for the protection of the bay against the United States squadron, but the Spanish vessels appear to have been absolutely thrown away in the encounter. That the Spaniards fought bravely we make no doubt, but something more than bravery was required, and the

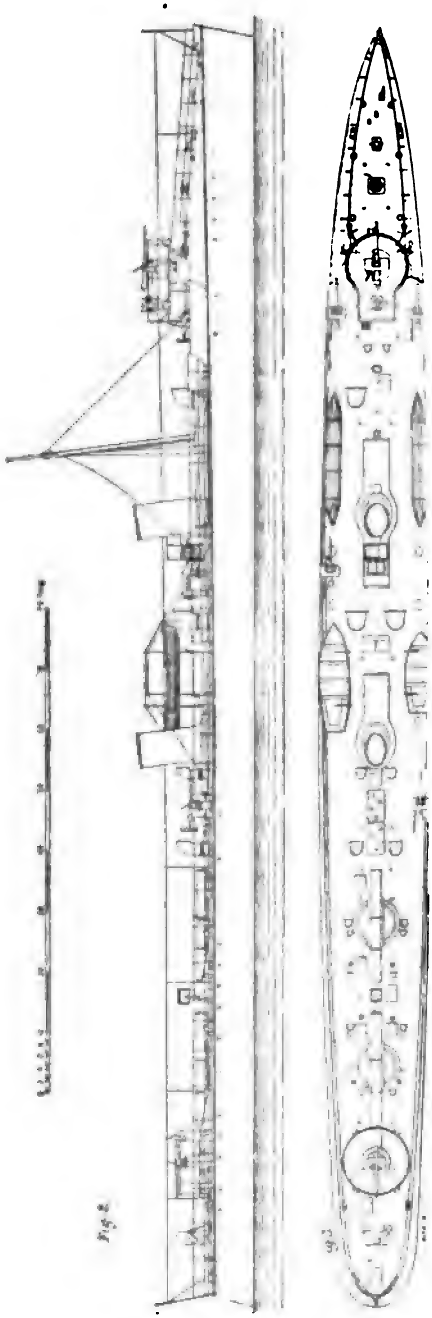


Spanish narrative of what happened leads us to believe that they were no more a match for their enemy in point of professional ability than were they in regard to the relative strength of the naval forces at their disposal. The depth of water at the entrance to the bay in either channel precludes the idea of the use of submarine mines, but there would seem also to have been none of those obvious and essential precautions which should have been taken

in the circumstances. It does not appear that the southern entrance was defended in any way, and the forts, therefore, on Mariveles Point and Corregidor island were useless except to give notice, but not a sufficiently timely warning, of the impending attack. It seems almost incredible that there should have been no patrol at the entrance to the bay. The smaller Spanish vessels were suitable for this purpose, and doubtless there were other steam vessels at hand which might have been utilized with the same object. As we are told that Admiral Montojo had taken his squadron to sea a few days previous to the action we cannot suppose that he was insufficiently supplied with coal, yet we find four torpedo vessels, indeed five, which might have been used to attack an incoming enemy with a fair prospect of success, placed in a position where their powers of offence were largely neutralized. To anchor such vessels as those which comprised the Spanish squadron in an open bay, even though they might be partially protected by the fire of forts, was in the circumstances to invite disaster. The wording of the official telegram from the Governor-General of the Philippines to the Minister of War at Madrid gives us a notion of his ideas of defence, and presumably of those of his naval adviser as well. He says that the enemy's squadron "forced a passage under the obscurity of night"! What did he expect otherwise? He must have known that he had to deal with a bold and enterprising adversary, of whom it might have been predicted that he would act with decision and in the manner best adapted to his purpose. Admiral Dewey deserves the congratulations and honors which have been showered upon him for the thorough manner in which he carried out a boldly conceived and brilliantly executed enterprise.

At the time of writing we are wholly without trustworthy information as to the number and type of the guns mounted in the shore batteries at Cavite, although there are said to have been 10-inch and 12-inch guns placed there recently. Nor do we know the distance at which the Spanish ships were placed from the shore, or the range at which the Americans engaged. These and many more particulars are needed to make clear what took place, and for them we shall have to await a complete account from American sources. How unequal the battle was between the ships needs little demonstration. On the Spanish side not a ship was "protected," and it seems likely that the guns were equally without shields of any kind. The so-called "protection" of the torpedo gun vessels *Isla de Cuba* and *Isla de Luzon* merely consists of a 2.5-inch steel deck over the engine room and boilers; the *Reina Cristina* had been used as a transport, and it is stated that some of her guns had been removed. The *Castilla* and *Mindanao* were wooden vessels, and the *Velasco* little more than an armed merchantman, while the *Don Antonio de Ulloa* and the *Don Juan de Austria*, though fairly good gunboats for colonial work, were like all the rest entirely unfitted for a modern engagement with well protected vessels. We notice that the *Olympia* in some reports is described as an ironclad. This is not the case, but she is an exceptionally well protected cruiser, and, if not alone, was with the *Baltimore* and *Raleigh* quite a match for the whole scratch pack of Spaniards. The other American vessels, although less well protected, were nevertheless superior in point of armament to most of their antagonists. If we include nothing heavier than a 4.7 gun a comparison of the armaments of the two squadrons stands thus: United States—Ten 8-inch, twenty-four 6-inch, and ten 5-inch quick-firers; Spain—Thirteen 6-inch, twenty-four 4.7-inch. The thirteen 6-inch Spanish guns actually comprised six 6.3-inch Hontorias, three 6-inch Armstrongs, and four 5.9-inch Krupps.

The immense superiority in armament is obvious, and when it is remembered, moreover, that their ships and batteries were much better protected no surprise can be felt at the result of the action being in favor of the Americans. The unknown factor —the guns in the Cavite batteries —may have done some damage to the United States cruisers, but the destruction of the Spanish flotilla should have been a foregone conclusion. It is for this reason that we are of opinion that the proper use to have made of it was at the entrance to the bay and for a night attack. It is quite conceivable that some people will jump to the conclusion that this engagement shows the relative power of ships and land defences to have undergone a change. If they do they will make a mistake. Even if it were possible for armorclad ships to engage shore batterise without coming off second best it is quite certain that the so-called "protected" vessel is not fitted to be risked in such an encounter. It may be permissible for the sake of preventing the completion of a work to throw a few shells, as Admiral Sampson did at Matanzas, but even this must be done at long range.



With regard to the situation in the Atlantic there has been very little definite information through the week. It would appear that both sides have now fully recognized the necessity for secrecy in regard to their movements. As we thought likely last week the departure of the Spanish squadron from Cape de Verde has had its effect, and we hear of a rearrangement and reconstitution of the blockading force. It was necessary, of course, to prepare a squadron which should be capable of meeting the Spaniards if they crossed the Atlantic. Whether the reports are true that instead of so doing this squadron has re-

to Cadiz seems doubtful, although if such a move were made for the e of concentration, much might be said in its justification. In default s the correspondents on the other side indulge in speculation, and appears to be divided as to whether Admiral Sampson left Key West dnesday last for the purpose of meeting the *Oregon* or to escort an tion for the capture of Porto Rico.

—*The Army and Navy Gazette*, May 7, 1898.

WAR-SHIPS AND TORPEDO BOATS.

H. M. S. "*Fame*."

he present and opposite pages we illustrate the torpedo-boat destroyer one of the recent and larger vessels of this type built to the order of lmiralty by Messrs. J. I. Thornycroft and Co., of Chiswick. Fig 1 is a

l view prepared from a very successful photograph taken when the was running at high speed. Figs. 2 and 3, on the opposite page, are a view and a deck plan showing arrangement of armament, etc.

Fame is 210 ft. long over all, the maximum beam being 19 ft. 6 in. and pth 13 ft 6 in. In other respects she closely resembles the *Daring*, a fully described in the columns on previous occasions.* The form of s that peculiar to the Thornycroft design, in which the after-part of the is flattened under water, the propellers, of which there are two, being the bottom. The engines are of the four-cylinder triple-compound type . Thornycroft have designed for vessels of this class, and which have already illustrated by us † The engines of the *Fame* are, however, hat more powerful than those of the *Daring*, the cylinders being 20 in., and two of 30 in. diameter, with a stroke of 18 in. There are three ycroft watertube boilers of the *Daring* type,‡ but these are naturally hat larger than those of the latter craft, in order to give the increased

Engineering, vol lvi., page 674, and vol. lvii., page 850.
Engineering. vol. lviii. page 575.
e boilers of the *Daring* were illustrated in *Engineering* vol. lvi., page 674.

power required for the higher speed of the larger vessel. There are three of these boilers, two being forward with a chimney in common, and one amidship with a single chimney.

The gun armament of the *Fame* is somewhat more powerful than that of the earlier vessels. There are five 6-pounder guns, two more than in the *Daring*. On the other hand, there are but two torpedo discharges, both of which are placed aft. The *Daring* had, in addition, a bow discharge, but the naval authorities consider this unnecessary for the later boats. No doubt in the arrangement of the armament the newer vessels more nearly fulfil the conditions suggested by the name of their class, and become more nearly torpedo-boat destroyers rather than torpedo-boats. There is, perhaps, some danger that an ambitious commander of these craft may turn his attention to small fry, and thus perhaps leave his larger consorts open to attack, to the frustration of the tactical plans of his Admiral. However, it would be a pity not to give the destroyers a chance to be useful in other fields than the distruction of torpedo-boats, which might not become an important factor in operations in progress. It will be the duty of the Admiral to keep his torpedo flotilla commanders well in hand, and any glory-hunting vagaries will have to be sternly dealt with, whatever their temporary success. This, of course, would not mean the destruction of all initiative on the part of separate commanders, when independent action could be undertaken without disobedience.

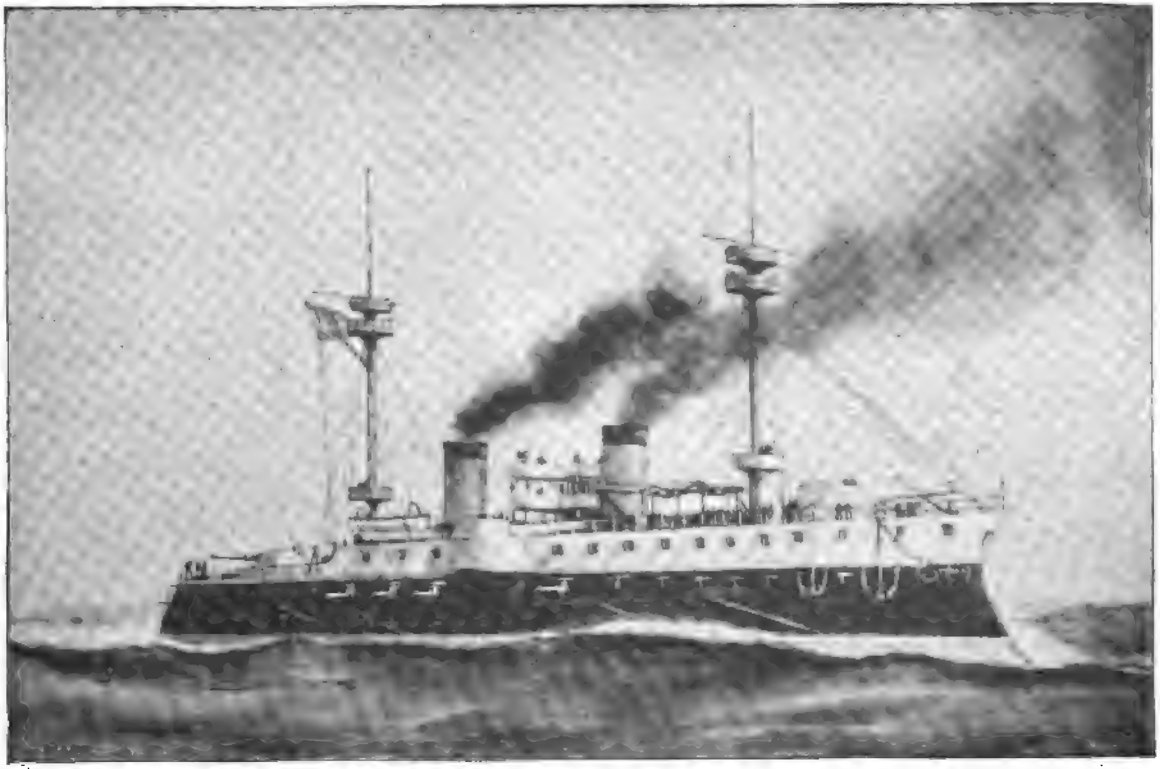
The *Fame* gave an excellent result on her trial trip, which was run on the Maplin measured mile. The draught forward was 5 ft. 1¼ in.; aft, 7 ft. 1 in:; and the speed was 30.155 knots. The boiler pressure was 205 lb. per square inch:; the air pressure in the stokehold 4 in., and the vacuum averaged 26.3 in. The revolutions were 394.8 for the starboard, and 393.1 for the port engines. The mean indicated horsepower in the starboard engines was 2914, and in the port engines 2980, or a total of 5894 indicated horsepower for both sets of engines. The *Fame*, it will be seen, did not reach quite the speed attained by the *Desperate*, the latter vessel making on unofficial trial 30.46 and 31.035 knots, with a load of 15 tons on board in place of 35 tons: An account of the *Desperate's* trials was given in our issue of March 27, 1896.

—*Engineering*, December 31.

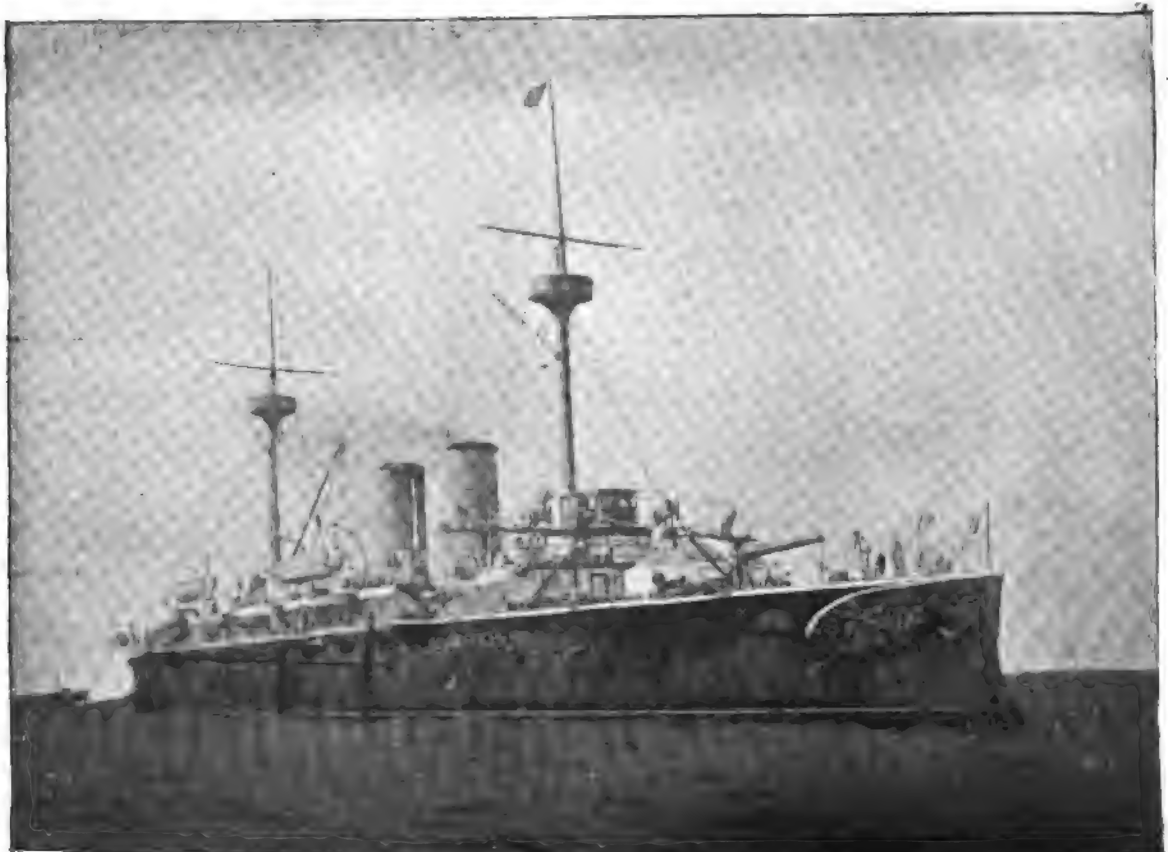
Spain's Naval Force.

In view of the probable outbreak of hostilities with the United States it may be interesting to give some details as to the naval forces Spain has available in the event of war.

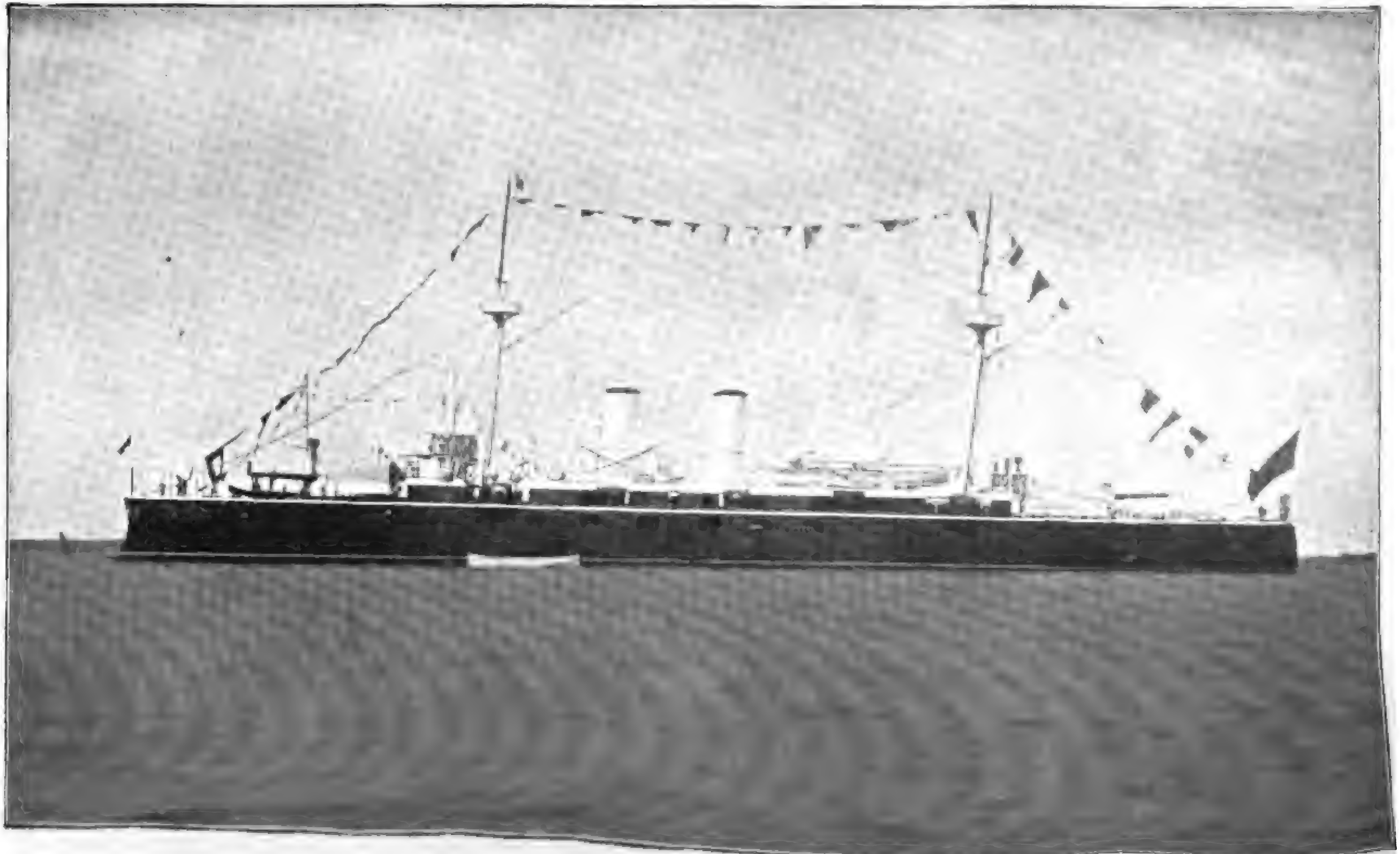
Her only battleship is the *Pelayo*, a vessel of 9,900 tons displacement, built in France at the La Seyne yard, near Toulon, and launched in 1887; she has lately undergone extensive repairs at the same yard, and Niclausse water-tube boilers have been substituted for her old cylindrical ones; she made 16 knots on her recent trial trip, and has since arrived at Cartagena. Protection is afforded by a complete water-line belt 17 inches in thickness, but tapering to 12 inches at the bow and stern, with two 15.7-inch transverse bulkheads, one forward and one aft, while there is a 4-inch armored deck. The armament consists of two 32-centimetre (12.5-inch) 48-ton Hontoria guns in armored barbettes, one forward and one aft; and two 28-centimetre (11-inch) 38-ton Hontoria guns, also in armored barbettes, one on each beam. All four turrets are protected by 18-inch armor with 6-inch steel hoods for the guns. The secondary battery now consists of nine 5.5-inch Q. F. guns, mounted one right forward and four on each beam in a central battery, with 20 small Q. F. and



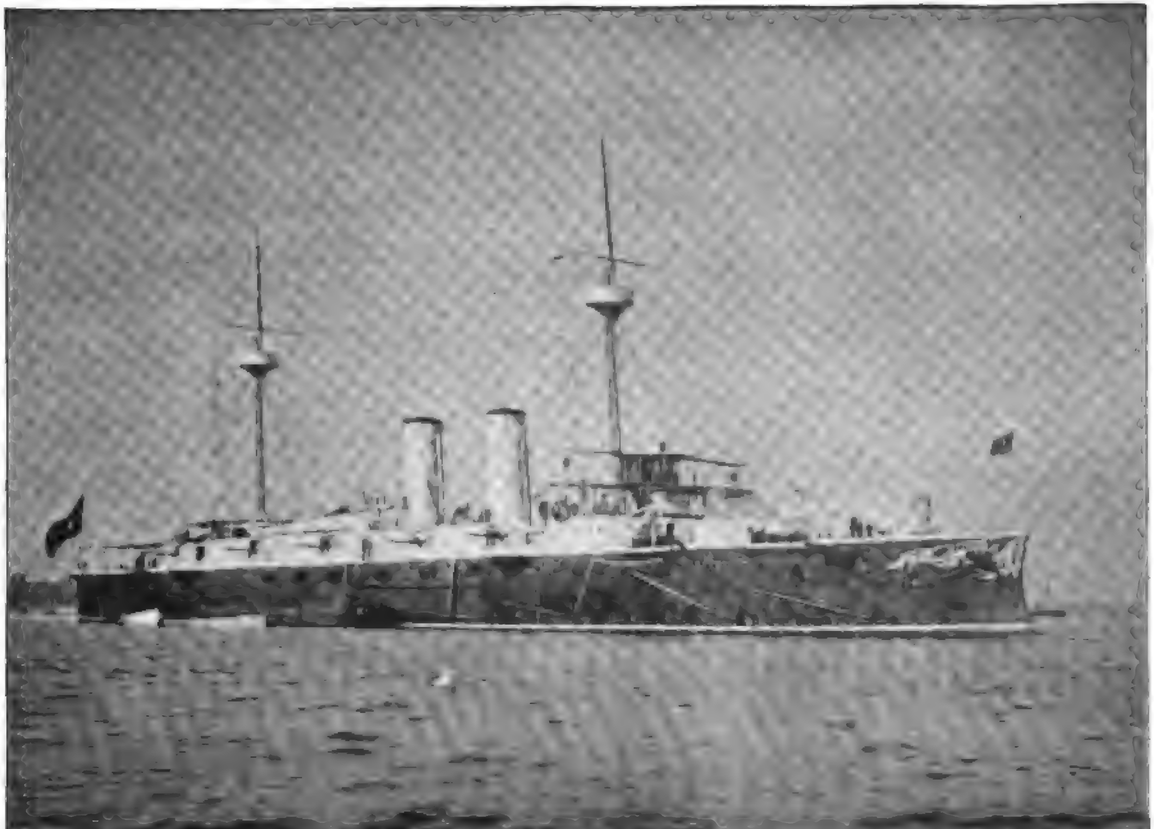
Pelayo.



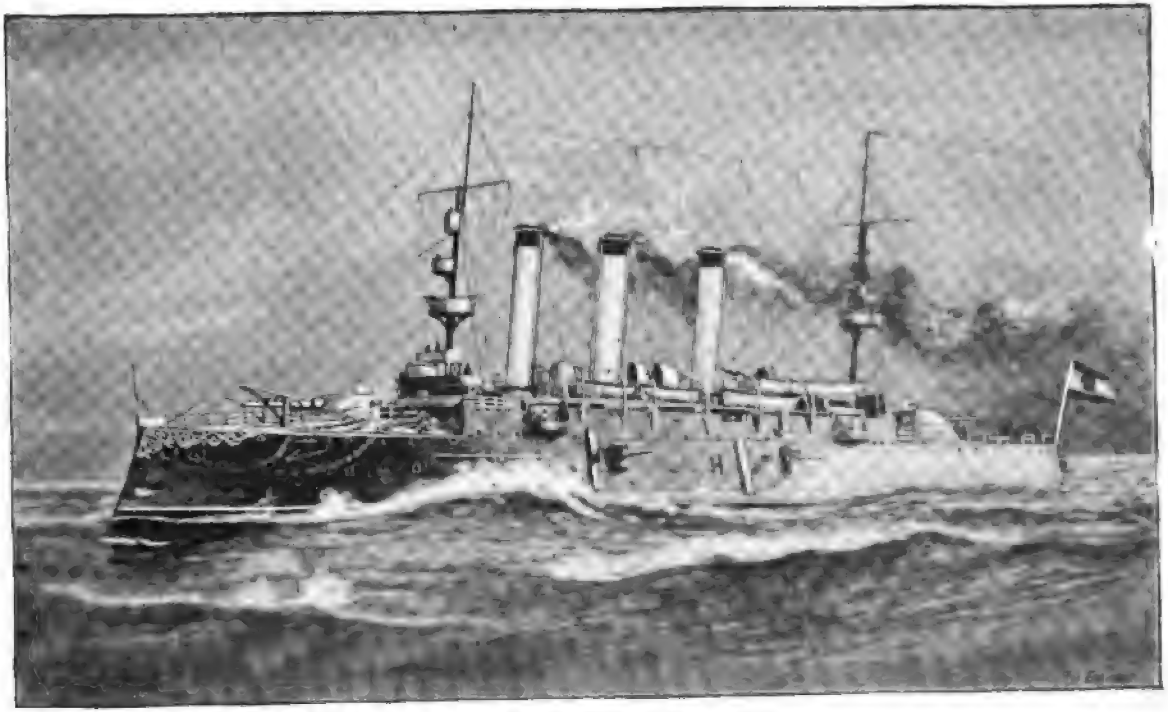
Vizcaya.



Viscaya.



Infanta Maria Theresa.



Carlos V.

machine guns and 7 torpedo-tubes. The engines develop 9,000-I.H.P., giving the ship a speed of 16 knots, while the coal supply is 1,000 tons.

She possesses five powerful armored cruisers ready for sea, the finest being the *Cristobal Colon*, purchased last year from the Italian Government. This vessel has a displacement of 6,840 tons, with engines developing 14,000-I.H.P., giving a speed of 20 knots; protection being afforded by a 6-inch complete belt of hardened steel, above which is a central redoubt, 120 feet long, similarly protected, at each extremity of which are barbettes also with 6-inch plating, one forward and one aft, with 6-inch transverse bulkheads protecting their bases, a 10-inch gun with steel hood being mounted in each; in the redoubt are mounted ten 6-inch Q. F., and on the superstructure six 4.7 Q. F. guns, with 20 small Q.F. and machine guns; her coal capacity is 1,000 tons. The other four vessels are the *Vizcaya*, of which we give a photograph; *Infanta Maria Teresa*, *Almirante Oquendo*, and *Emperator Carlos V*. The first three are sister ships, vessels of 7,000 tons, with engines developing 13,000-I.H.P., giving a speed of 20 knots; they have a 12-inch belt, with 3-inch armor deck, and carry two 11-inch guns, one forward and one aft in barbettes protected by 10-5-inch armor, the guns being protected by hoods, while the secondary battery consists of ten 5.5-inch Q.F. guns, with 20 small Q.F. and machine guns and 8 torpedo tubes. The *Emperator Carlos V*, is of a somewhat different type, as she has no belt, but instead a 6.5-inch turtle-back armored deck, a central battery protected by 2-inch armor for her 5.5 inch Q.F. guns, the barbettes for her two 11-inch guns having 10.5-inch armor; her displacement is 2,000 odd tons larger, being 9,235, while her engines develop 18,500-I.H.P., but she is only credited with the same speed, viz., 20 knots. There are four other vessels of the *Vizcaya* type under construction and completing, one of which—the *Princesa de Asturias*—is nearly ready for sea, and it is further reported that the Government have purchased the first-class armored cruiser *Varese* (a sister ship to the *Cristobal Colon*) from the Italian Government, but she will not be ready for sea for some time yet.

Of smaller cruisers of any value with speeds from 14 to 20 knots, Spain has 24, and of these the *Alfonso XII.*, a cruiser of 5,000 tons and engines of 11,000 I.H.P., with a speed of 20 knots, is the largest; but 11 out of the 24, it should be noted, are vessels of under 1,000 tons displacement, although they all have speeds varying from 18 to 20 knots; and she has, moreover, a powerful little flotilla of five 30-knot torpedo-boat destroyers, all lately completed by Thomson, of Clydebank. Although the Spanish navy is not likely to be able to effect much against the coast towns of the United States, defended as they will be by the powerful home defence fleet concentrated there, yet it ought to be able to do effective damage against the now considerable United States mercantile marine, especially as it is unlikely that any attack could be successfully made against the Spanish arsenals and seaport towns, from some of which their cruisers could undoubtedly operate against the United States trade routes.

—*Journal United Service Institution*, April, 1898.

Spain's Armored Cruisers.

The admission of vessels into the category of armored cruisers is governed so much by individual fancy that the term is in many cases very misleading. It might well be divided into at least three sub-heads, or else abolished altogether, for at present variations are so great that comparisons between

ships designated as "armored cruisers" are well nigh impossible. There are cruisers, all called "armored," without any other distinction: (1) With armor on both guns and belt; (2) with armor on belt only; (3) with armor on the guns only. To the latter class the Spanish cruiser *Carlos V.* belongs, but as a general—and quite unreasonable—rule, ships with armor for the guns only, like our *Powerfuls*, are classed as first-class protected cruisers, while a thin 3-inch belt will dignify them with the title of armored cruisers. If we compare the majority of Spanish cruisers, the *Vizcaya* and *Infanta Maria Teresa* class with their battleship *Pelayo*, we see that the sole difference between them is that where the *Pelayo* has a belt all round her, the *Vizcayas* have a partial belt for three-quarters of their length and bulkheads. The *Pelayo* has, of course, four big guns against their two, but then she is the bigger ship.

In both cases the guns are identically protected, a narrow barbette, with nothing below save an armored hoist. In each case a thin shield covers the gun breech—a foolish thing probably, since it is just sufficiently thick to burst a shell, and far too thin to keep anything out. Before *Yalu* the Chinese removed these shields from their battleships, and there was probably wisdom in so doing, though we must bear in mind that the Japanse have since replaced them in the *Chin Yen*. Probably, however, the new shields are of tougher armor, but on that no details are available.

We find, therefore, that to all intents and purposes the Spanish *Vizcaya* class are battleships of the second class, slightly armored, it is true, yet with more armor than the Italian *Lepanto* carries, since that "ironclad" has no belt at all. A vessel which—save that she has a 2-inch armor over the quick-fire guns—is identical to the Italian *Lepanto* in the arrangement of armor is the *Carlos V.* She has no belt, but a very thich deck—6-inch—her big guns in fore and aft barbettes alone are armored. The arrangement of guns is, of course, quite different to the *Lepanto's*, but the "idea" in both ships is similar. This idea is that a belt of coal and cellulose, with a thick deck below it, is quite equal to a heavy belt of armor. So far as protecting the engines goes this is true; and it *may* prove true in other ways. At the best, a belt is only a strip, liable to penetration above and below in a sea way.

The *Christobal Colon* could, and no doubt will, "lie in the line" if there is a naval action; she is proof against every sort of shell. Except her and the *Pedro d'Aragon*, now building, which carry 10-inch guns, all the Spanish armored cruisers carry a couple of 11-inch guns; very good pieces, able to penetrate all the armor on the American battleships' guns.

The American armored cruisers are quite different; they are really armored cruisers. Their belts, instead of being 12-inch steel as in the *Vizcayas*, are of 3-inch steel only; their big guns are only of 8-inch caliber. Now. an 8-inch projectile is quite useless against the belts of the *Vizcayas*, or against their barbettes, and in engaging such ships shell fire alone could be depended on to do anything. Of course, shell fire is the staple attack, but the *Brooklyn* and *New York* can do nothing against the Spaniards, with their comparatively feeble 8-inch shell, that the Spaniards cannot do against them with a far more powerful gun. It is rank heresy maybe, but we cannot but hold that there is a tendency to unduly glorify the small quick fire gun or the medium-sized 8-inch. The chances of hitting are, of course, greater with the smaller weapon, both from its extra rapidity and its extra numerical quantity; but when the big shot does hit its effect will be, of course, far greater. However, the *métier* of the Spanish and American armored cruisers is quite different, and it is profitless to compare them. Spain's force is really a number of

second-class battleships—known as "armored cruisers"—and these will be pitted against a much smaller number of first-class American battleships. The "many eggs in one basket" is, when all things are considered, the best for battleships. America, therefore, apart from other considerations, should win. It is not very safe to prophesy anything, but the probabilities are either a "walk over" for one side, or else an absolutely indecisive but sanguinary result. There is not likely to be a mean between these extremes.

The other principal data with regard to the vessels referred to above, are as follows:—The *Vizcaya* is an armored cruiser, launched at Bilbao in 1891, carrying two 11-inch guns in two barbettes, and ten 5.5-inch guns, besides smaller weapons. Her displacement is 7000 tons, her length 340 feet, breadth 65 feet, and maximum draught 21 feet, 6 inches. She is propelled by twin screws, her engines developing 13,000 horse power. Her normal coal supply is large, namely, 1200 tons, sufficient to take her nearly 10,000 miles at 10 knots. Her maximum speed is 21 knots. With the exception of the *Pelayo*, she and the vessels of the same class are the most heavily armored in the Spanish navy. They have belt armor 12 inches thick, extending from bow to stern, but tapering off at the extremities; their big guns are protected by 10½-inch armor, and the deck plating is 3 inches thick. The *Infanta Maria Teresa*, also built at the same time and in the same yard, developes rather more power, but is armed and protected in the same way, and is of the same dimensions. Both ships have six torpedo tubes. The *Almirante Oquendo*, *Cataluna*, *Cardenal Cisneros*, and *Princessa de Asturias* are all very nearly the same in dimensions, and all carry the same guns and armor, so that these six ships form a valuable squadron, and as the slowest of them can steam 20 knots, they ought, if combined, be able to give a very good account of themselves.

The *Christobal Colon*, originally *Giuseppe Garibaldi II.*, is of rather less displacement—6840 tons—and indicates 14,000 horse power, but makes only the same speed as the *Vizcaya* class. Her main armament consists of two 10-inch guns and ten 6-inch, and six 4.7-inch and four torpedo tubes, so that she is powerful in this respect. She is protected by a 6-inch belt of Harveyed steel, and her guns are similarly provided. Her deck plating is 1½ inches thick. Her normal coal supply is 1000 tons. She was launched at Sestri Ponente in 1896.

—*The Engineer*, April 29, 1898.

The Spanish Warships *Carlos V.* and *Pelayo.*

The *Carlos V.* is one of those ships concerning whose details there is a considerable amount of doubt. According to "Brassey," who classes her as an armored cruiser, she is of 9235 tons, carries two Hontoria 11-inch guns in barbettes, plated with 10-inch steel, eight 5.5-inch quick-firers, four 3.9-inch quick firers, and six small quick-firers. The same authority gives her a 2-inch belt and a 6-inch deck. His plans of the ship, however, give her ten instead of eight 5.5-inch guns, and 17¾-inch armor on barbettes, a 2-inch skin over the entire amidships battery, but no deck. The "Naval Pocket Book" description accords mostly with this plan, but the tonnage is given as 9000, and the barbette armor 9.8-inch. "All the World's Fighting Ships" corresponds with the "Pocket Book" description, but gives fewer details. On the other hand, French papers speak of her positively as having a 6-inch belt; and when the ship was lying at Havre recently she looked to have a narrow belt for about one-third of the water-line amidship. The ship was then complete save for

her big guns, and our illustration is from sketches and photographs taken of her then, about Christmas, 1897.

To look at, her arrangement of armament seems certainly similar to that of the *Edgar* class, saving always the fore-and-aft barbettes. These, like those of some Italian cruisers, do not correspond, the after one having the plates apparently set at an angle, while the forward one, which rises out of a slight turtle back, has vertical sides. Further details of the ship are: Length, 380 ft.; breadth, 67 ft.; draught, 25 ft. There is, unfortunately, no way of determining whether this is the mean or maximum draught. The maximum horse-power, forced draught, is 18,500, the trial speed 20 knots. The coal capacity —normal—is 1200 tons, but 600 tons extra can be stowed. She was launched at Cadiz in 1895, and in the ordinary course of Spanish shipbuilding would not have been completed for some two or three years yet. Her cost is reported at £750,000, £150,000 more than the *Vizcaya* class, which have a stout belt and an identical armament; 600 tons less coal capacity, 2000 tons less displacement, and 5000 tons less indicated horse-power in the case of *Vizcaya*, but very little less in the case of the *Cisneros*. Our *Blake* cost less than £450,000—roughly £50 a ton. Our *Undaunteds*, small *Vizcayas*, armed identically as the *Blakes*, cost about £50 a ton also. The cost of the *Carlos V.* works out at £83 a ton, of *Vizcaya* class £85 a ton. The *Carlos V.* has six above-water torpedo tubes, and probably two submerged tubes; but here again no really authentic information is obtainable.

The *Pelayo* was launched at La Seyne 11 years ago. She is of the same type as the French *Marceau*, having her four big guns disposed lonzenge-wise on the French system. This ship is of 9900 tons, with a complete 18-inch steel belt and 19-inch on the heavy gun positions. The protective deck on top of the belt is 3½-inch steel. The big gun hoists are 11.8-inch steel. The big guns are two 12.5 Hontorias, one forward and one aft, and an 11-inch Hontoria in each of the side barbettes. She has only recently left La Seyne, where a very complete refit has been partially carried out. Niclausse boilers have been fitted of 9000 indicated horse-power, in place of the old ones of 8000 indicated horse-power. The engines used to be vertical compound, and the screws two with four blades each. The maximum coal capacity was 800 tons, but she can probably stow 1000 now. The boilers are much lighter than the old. A reduction has been made in the secondary armament. It used to be one 6.2-inch breech-loader on the forecastle, twelve 4.7-inch breech-loaders on the main deck in an unprotected battery, one 3.5-inch breech-loader, and two 2.7-inch breech-loaders. The new armament, so far as one can gather, appears to be only eight 5.5-inch quick-firing Canet guns. "Brassey" gives nine 5 5-inch guns, and six smaller pieces. The saving in weight was to be applied to putting armor over the battery, bulkheads, and shields, but from all accounts only the latter had been fitted when she left La Seyne in consequence of the nearness of war. Being light, she will therefore be able to stow extra coal without undue submersion—an important thing, seeing how hampered for coal Spain is. There are seven above-water torpedo tubes.

—*The Engineer*, May 6, 1898.

The Spanish Cruiser *Vitoria*.

We have, on several occasions, called attention to the great work undertaken by the La Seyne works in transforming the Spanish frigates *Vitoria* and *Numancia* and increasing the fighting power of the *Pelayo*. Although differing greatly in value, these three vessels, for different reasons, constitute

factors of great importance in the naval reorganization which Spain is now carrying on. The two first mentioned are to be entirely reconstructed, while the *Pelayo* will be simply improved by a change of boilers, involving an economy in weight.

The important changes to be made in these ships have been pushed with great energy. The *Vitoria*, already finished, left Toulon on March 1st for Carthagena, to take on board her new artillery. The *Pelayo*, which has just gone into dock at Toulon, after her trial there, has been put in condition to proceed to Spain with all dispatch. There only remains, then, the completion of the work on the *Numancia*, which is being carried on with the greatest energy.

The *Vitoria*, a photograph of which taken in Toulon is given herewith, is an armored frigate, launched in 1865 by the Thames Iron Works. Owing to progress of every kind, so many modifications in the construction of warships have been necessary in the thirty-three years since the *Vitoria* first saw the light, that it was hardly possible to make use of this old frigate without having her completely reconstructed. It is not without interest to notice, however, that in the *Vitoria*, as in the *Numancia*, built in France in 1863, the main characteristic of defensive power (having the whole hull completely armored) happens to be exactly in harmony with modern ideas applied quite recently to certain armored cruisers of various navies. As a result, the *Vitoria* and *Numancia* carry iron armor, varying in thickness from 14 to 11 cm. (5.5 to 4.3 inches) protecting all the freeboard of the ship up to the upper deck; the gun ports even are armored. This armor is covered with a layer of wood which conceals its nature, one quite formidable for the period in which the vessel was built.

The *Vitoria* possesses the following characteristics:

Length	316.50 feet.
Beam	56.89 feet.
Draught	24.00 feet.
Displacement	7250.00 tons.

Her sail area having been greatly reduced, the *Vitoria* possesses for motive power only a single screw driven by a low pressure engine made at the Penn works. This engine, capable of developing 4000 horse power, and of giving the vessel, under favorable conditions, a speed of 11 knots, is fed with steam from eight boilers of the Admiralty type, the fire tubes of which open into the two smoke-stacks. The old boilers have been replaced by eight new ones of the same Admiralty type.

But above all, the installation of new artillery and the results secured thereby constitute the most important improvement made in the vessel. The *Vitoria* was originally armed with eight 9-inch Armstrong guns, mounted broadside and throwing projectiles weighing 250 pounds; and three 7-inch (18 cm.) Palliser guns, one bow-chaser forward, and the two others amidships in the redoubt.

These pieces have been removed and arrangements made to receive the following pieces which have been since mounted on board in Spain:

1. Six 6.3-inch (16 cm.) guns, Hontoria system, distributed as follows: two forward in the bow, in the ports formerly existing there; two amidships, one on each side in the armored redoubt of the deck, on center-pintle carriages; two aft, one on each side in the upper deck in sponsons forward of the poop, mounted on center-pintle carriages and provided with revolving shields.

2. Eight 5.5-inch (14 cm.) rapid-fire broadside guns, Schneider-Canet system, placed four on each side in battery amidships, on center-pintle carriages and protected by revolving shields.

3. Six 2.24-inch (57 mm.) Nordenfelt rapid-fire guns, mounted on each side: two on the poop, two on a new bridge built across the middle of the ship, and two on the forecastle.

4. Six 1.45-inch (37 mm.) Maxim rapid-fire automatic guns: two mounted in the top on the foremast, two in the top on the mainmast, two in reserve for landing parties.

Magazines have been provided for the ammunition of all these new pieces. The service of the latter has been assured by suitable ammunition-lifts which are hoisted in conduits of iron by means of windlasses run by motors. There are twelve of these windlasses; four for the 16 cm. ammunition, four for the 14 cm. ammunition, two for that of the 57 mm. guns, and two for the service of the 37 mm. pieces.

These installations naturally have demanded a complete reconstruction of the interior with consequent change of all the parts that could not be utilized. The decks have been suitably reinforced at such places as was necessary.

The aspect of the ship has been completely modified by changing her masts, which used to be three in number, square-rigged. As is seen in the photograph, these have been replaced by two small metal masts, each carrying a top, one yard and topmast for signals. A new reduced sail area has been provided in consequence of this change.

When mention has been made of two directly coupled engines and dynamos, of 350 amperes at 80 volts, for furnishing the needed electrical energy, (lighting, projectors and signals) we will have given, in broad lines, the changes which now allow the *Vitoria* to figure once again in Spain's navy, the flag of which she has already borne so many years.

In spite of her speed, which is very inferior compared to that of present fighting units, the *Vitoria* could render very efficient service when demanded, on account of her most modern artillery and the large amount of protection she has.

—*Le Yacht*, April 2, 1898.

A. H. Jr.

GENERAL MILITARY MATTERS.

Kuropatkin: War Lord of Russia.

General Alexei Nicolaievitch Kuropàtkin, who was appointed acting minister of war on New Year's Day, is the greatest "fighting general" in the Russian army. He has won every distinction "for valor" in the field that the imperial crown holds in its gift; he has "swords of honor" enough to arm a company; he has seen active service in three continents—Africa, Europe, Asia—from Mount Atlas to Chinese Tartary; he was one of the decisive factors in the last great decisive battle fought on European soil. Further, General Kuropàtkin is the best writer of military history in Russia, the master of those who know in the science of war. In his forty-ninth year, and in the very prime of vigor and power, he is lord of the greatest army in the world—5,000,000 men in time of war. No finer augury could have been imagined for Russia's hopes in the new year and the new century than the destiny which calls this wisest warrior to lead the armies of the Czar.

In 1866 Alexei Kuropàtkin got his commission as sub-lieutenant in the Turkestan rifles, attracted thither by the voice of war. With the rank of

lieutenant, Kuropàtkin returned to St. Petersburg to continue his studies in the science of war in the academy of the general staff. In those days the curled darlings of the most favored home of learning were nicknamed "pheasants" by the plain-plumed students of the other schools. They had favors at court balls, special opportunities for flirtation, and floods of social sunshine in that most distinguished metropolis. After the Turkish war they were called the "moments," because they so often sought and missed the psychological moment in a battle. If Lieutenant Kuropàtkin wore fine feathers, he worked hard. He completed his studies in 1874, coming out triumphant at the head of his year. The best student is annually rewarded. Lieutenant Kuropàtkin received a special allowance to continue his studies abroad. After a brief visit to Berlin he hurried on to Paris. Shortly after this Kuropàtkin was invited to take part in the maneuvers around Metz, where he showed such remarbable strategic ability that the French authorities enthusiastically made him *Officier de la Legion d'Honneur*. Alexei Kuropàtkin was thus the first Russian officer to receive this decoration for distinguished military services. From Metz the scene suddenly changes to Algiers, sacred to Tartarin and the Atlas lions. Kuropàtkin had better luck than the Tarascon hero. For eleven months he rode through the length and breadth of the land with a column under General Laverdeau, in the expedition of the Great Sahara, through the oasis of Mzab to Wargla.

From Algiers Kuropàtkin returned to the Norway winters and Persian summers of Turkestan. At this time Chinese Tartary was the hunting-ground of Yakub Bek of Kashgar, a man with something of Genghis Khan and Timur in him. Kuropàtkin was sent over the border into the wilds to find Yakub Bek and settle the frontier. Just round the corner of the Pamirs, near Osh in the Tian Shan mountains, his escort was set on by a swarm of Kara-Kirghiz nomads, the very material of conquering Tartar hordes. Alexei Kuropàtkin continued his journey through the wilds with a wounded arm and a stronger escort. He was among unknown deserts wilder than the Sahara. The expedition lasted a year, and 2,500 miles were covered on horseback. Kuropàtkin gained some diplomatic glory and wrote a book on Kashgaria, awarded the geographical society's gold medal, like the volume on Algiers.

For services in the Russo-Turkish war Colonel Kuropàtkin was awarded the golden sword of honor "for valor," and the crosses of St. Stanislav and St. Anne of the second class and St Vladimir of the third class, all with swords of honor. He is the only Russian general who holds the St. Stanislav and St. Anne crosses of the second class with swords of honor. "Lovcha, Plevna, Sheinovo," and "The Actions of General Skobeleff's Division" were added to the list of his writings. At the close of the war Kuropàtkin was appointed director of the Asiatic department of the general staff and joint professor of military statistics in the academy from which he had issued, as its most brilliant student, five years before. But he was not destined to enjoy long rest in the northern capital. There was trouble again on the borders of Turkestan, and Kuropàtkin was put in command of the Turkestan rifle brigade. At the siege of Geok Tépé, as commander of the right wing and afterward the center of the attack, the brunt of the battle fell on Kuropàtkin. The Turcomans were foemen worthy of the victors of Lovcha and Sheinovo. When in command of the chief storming column Kuropàtkin forced a way into the fortress by a brilliant piece of mining, and laid the foundations of a complete conquest of the Turcoman marauders - the last dregs of the great Mongol hordes. The cross of St. George of the third class and the rank of major-general

record his doings in this Turcoman campaign. Then Skobeleff's sun set in a splendid carouse, to rise again in Valhalla.

From 1883 to 1890 General Kuropàtkin was busy with the work of the general staff, and played a leading part in that reorganization of the Russian army which marked the reign of Alexander III. This reorganization involved the application of the best and wisest modern standards throughout the whole army, which is now, in point of discipline, equipment, organization and knowledge, the equal of any in the world. In moral force, courage, and unity it is probably without equal. What remains to tell of Kuropàtkin's life up to New Year's day, when he became minister of war, is of high interest and value, though it can not compare, for stirring dramatic power, with what has gone before. On March 27, 1890, he was appointed governor of the Transcaspian province and promoted to the rank of lieutenant-general. It is admitted on all hands that the fruits of his rule show the wisdom of his appointment. He has completely pacified the Turcoman hordes, and carried far on the road to success that process of absorption which seems to be Russia's secret in dealing with Asian peoples. Contact with Russian rule seems to confirm and strengthen their national genius and steady them in the true path of their natural development.

All along General Kuropàtkin has steadily worked to strengthen the Russian colonizing element. And now, with the widest knowledge and experience to supplement his inherent genius and power, Alexei Nicolaievitch Kuropàtkin is called to the supreme post of power, the lordship of the Russian army, with its 5,000,000 men in time of war.

—*Public Opinion*, May 19, 1898.

Range Table for 4.7-inch (12-cm.) Q. F. Gun. Charge 8 lbs. 2½ oz.; Weight of Projectile 45 lbs.; Muzzle Velocity 2600 f.s.; Jump 3½ minutes to be subtracted from angle of departure.

By Major JAMES M. INGALLS.

Range.	Angle of Departure.		Five minutes elevation will alter range by	Five minutes will alter point of impact vertically at each range	Slope of descent.	Time of flight.	Remaining velocity.
yds.	°	'	yds.	feet.	one on	"	f.s.
100	0	2.5	202	1.7	1357.0	0.11	2555
200	0	5.0	197	2.0	665.4	0.23	2510
300	0	7.6	192	2.3	433.3	0.35	2466
400	0	10.3	188	2.6	317.8	0.47	2422
500	0	13.0	184	3.0	248.5	0.60	2379
600	0	15.8	179	3.4	202.2	0.73	2336
700	0	18.7	174	3.8	169.2	0.86	2294
800	0	21.6	170	4.2	144.5	0.99	2253
900	0	24.6	166	4.6	125.3	1.12	2212
1000	0	27.7	162	5.0	110.0	1.26	2171
1100	0	30.9	158	5.4	97.5	1.40	2131
1200	0	34.1	154	5.8	87.1	1.54	2091
1300	0	37.5	150	6.2	78.4	1.69	2052
1400	0	40.9	146	6.6	70.9	1.84	2014
1500	0	44.4	142	7.0	64.5	1.99	1976
1600	0	48.0	139	7.5	58.5	2.14	1939
1700	0	51.7	135	7.9	53.6	2.29	1902
1800	0	55.5	132	8.3	49.2	2.45	1865
1900	0	59.4	128	8.8	45.3	2.61	1829
2000	1	3.4	125	9.2	42.0	2.78	1794
2100	1	7.5	122	9.6	39.4	2.95	1760
2200	1	11.7	118	10.0	36.9	3.12	1726
2300	1	16.1	115	10.4	34.5	3.30	1693
2400	1	20.5	112	10.8	32.2	3.48	1660
2500	1	25.1	109	11.2	30.0	3.66	1628
2600	1	29.8	106	11.7	27.9	3.85	1596
2700	1	34.7	103	12.1	25.9	4.04	1565
2800	1	39.7	99	12.5	24.1	4.23	1535
2900	1	44.8	96	13.0	22.5	4.43	1505
3000	1	50.1	93	13.4	21.0	4.63	1476
3100	1	55.5	90	13.8	19.9	4.84	1447
3200	2	1.1	87	14.1	18.9	5.05	1419
3300	2	6.8	85	14.5	17.9	5.26	1392
3400	2	12.8	82	14.9	16.9	5.48	1366
3500	2	18.9	79	15.3	16.0	5.70	1340
3600	2	52.2	77	15.8	15.2	5.93	1315

RANGF TABLE FOR 4.7-INCH (12-cm.) Q. F. GUN.

Range.	Angle of Departure.		Five minutes elevation will alter range by	Five minutes will alter point of impact vertically at each range	Slope of descent.	Time of flight.	*Remaining velocity.
yds.	°	′	yds.	feet.	one on	″	f.s.
3700	2	31.7	75	16.2	14.4	6.16	1291
3800	2	38.4	73	16.7	13.6	6.39	1268
3900	2	45.2	71	17.1	12.8	6.63	1246
4000	2	52.3	69	17.5	12.0	6.88	1225
4100	2	59.5	67	17 9	11.4	7.13	1205
4200	3	7.0	65	18.4	10.8	7.39	1186
4300	3	14.6	64	18.8	10.2	7.65	1169
4400	3	22.5	62	19.2	9.6	7.91	1152
4500	3	30.6	60	19 6	9.0	8.17	1136
4600	3	38.9	59	20.0	8.6	8.44	1122
4700	3	47.4	57	20.4	8.2	8.71	1108
4800	3	56.2	56	20.8	7.8	8.98	1095
4900	4	5.2	54	21.2	7.4	9.26	1083
5000	4	14.4	53	21.6	7.1	9.54	1071
5100	4	23.9	52	22.0	6.8	9.83	1060
5200	4	33.6	51	22.5	6.6	10.12	1049
5300	4	43.5	49	22.9	6.4	10.41	1039
5400	4	53.6	48	23.3	6.2	10.70	1029
5500	5	4.0	47	23.7	6.0	11.00	1020
5600	5	14.6	46	24.1	5.8	11.30	1011
5700	5	25.5	45	24.5	5.6	11.60	1003
5800	5	36.6	44	25.0	5.4	11.91	995
5900	5	47.9	43	25.4	5.2	12.21	987
6000	5	59.4	42	25.8	5.0	12.52	979
6100	6	11.2	41	26.2	4.8	12.83	972
6200	6	23.2	41	26.6	4.6	13.14	965
6300	6	35.4	40	27.1	4.4	13.46	958
6400	6	47.9	40	27.5	4.2	13.77	951
6500	7	0.6	39	27.9	4.0	14.19	944
6600	7	13.5	39	28.3	3.8	14.51	937
6700	7	26.7	38	28.7	3.6	14.83	931
6800	7	40.1	38	29.1	3.4	15.15	925
6900	7	53.7	37	29.5	3.2	15 47	919
7000	8	7.6	37	30.0	3.0	15.80	913

Range-table for 10-inch B. L. Rifle, steel. Service charge 260 lbs. brown prismatic powder. Projectile 575 lbs.; muzzle velocity, 2025 f. s.; tabular velocity, 2000 ± 50 f. s.

By Major JAMES M. INGALLS.

Range.	Angle of departure. ϕ		For $\Delta C = \pm\frac{1}{16}C$ $\Delta\phi \pm$	For $\Delta V = \pm 50$ f. s. $\Delta\phi \mp$	Time of flight.	Drift.	Deviation for 10 miles of wind.	Fall: Angle of		Fall: Slope of	Maximum ordinate.	Striking velocity.	Penetration steel.
Yds.	°	′	″	″	sec.	Yds.	Yds.	°	′		ft.	f. s	in.
1000	0	43.4	0.2	2.2	1.58	0.4	0.3	0	45	75.7	10	1869	18.8
1100	0	48.0	0.2	2.4	1.74	0.4	0.4	0	50	68.8	12	1856	
1200	0	52.6	0.3	2.6	1.90	0.4	0.4	0	55	62.5	14	1844	
1300	0	57.2	0.3	2.9	2.07	0.5	0.5	1	1	56.8	17	1831	
1400	1	1.9	0.4	3.1	2.23	0.5	0.6	1	6	52.1	19	1819	
1500	1	6.7	0.5	3.3	2.40	0.6	0.7	1	11	48.4	22	1806	
1600	1	11.5	0.5	3.5	2.57	0.7	0.7	1	17	44.6	25	1794	
1700	1	16.3	0.6	3.8	2.73	0.7	0.8	1	23	41.4	29	1782	
1800	1	21.1	0.7	4.0	2.90	0.8	0.9	1	28	39.1	33	1770	
1900	1	26.0	0.8	4.3	3.07	0.9	1.0	1	34	36.6	37	1758	
2000	1	31.0	0.9	4.5	3.24	1.0	1.1	1	40	34.5	41	1746	17.1
2100	1	36.0	1.0	4.7	3.41	1.1	1.2	1	46	32.6	46	1731	
2200	1	41.0	1.1	5.0	3.58	1.2	1.3	1	52	30.9	51	1723	
2300	1	46.1	1.2	5.3	3.75	1.4	1.4	1	58	29.2	56	1711	
2400	1	51.2	1.4	5.5	3.93	1.5	1.5	2	4	27.8	61	1700	
2500	1	56.4	1.5	5.8	4.10	1.6	1.6	2	10	26.4	67	1688	
2600	2	1.6	1.6	6.0	4.28	1.8	1.7	2	17	25.1	73	1677	
2700	2	6.9	1.8	6.3	4.46	2.0	1.8	2	23	23.9	79	1666	
2800	2	12.3	1.9	6.6	4.64	2.1	1.9	2	30	22.8	86	1654	
2900	2	17.7	2.0	6.8	4.82	2.3	2.1	2	37	21.8	93	1643	
3000	2	23.2	2.2	7.1	5.00	2.5	2.2	2	44	20.9	100	1632	15.5
3100	2	28.7	2.3	7.4	5.18	2.7	2.3	2	51	20.0	108	1621	
3200	2	34.3	2.4	7.6	5.37	2.9	2.5	2	58	19.2	116	1610	
3300	2	40.0	2.6	7.9	5.56	3.2	2.6	3	6	18.4	124	1600	
3400	2	45.7	2.7	8.2	5.74	3.4	2.8	3	13	17.7	133	1589	
3500	2	51.4	2.9	8.5	5.93	3.6	2.9	3	21	17.2	142	1578	
3600	2	57.2	3.1	8.7	6.12	3.9	3.1	3	29	16.4	151	1568	
3700	3	3.1	3.3	9.0	6.32	4.2	3.3	3	36	15.8	161	1557	
3800	3	9.0	3.5	9.3	6.51	4.4	3.5	3	44	15.2	171	1547	
3900	3	14.9	3.7	9.6	6.70	4.7	3.7	3	53	14.7	181	1536	
4000	3	20.9	3.9	9.9	6.90	5.0	3.9	4	1	14.3	192	1526	14.1
4100	3	26.9	4.2	10.2	7.10	5.3	4.1	4	9	13.8	203	1516	
4200	3	33.0	4.4	10.5	7.29	5.6	4.3	4	18	13.4	215	1505	
4300	3	39.2	4.7	10.8	7.49	5.9	4.6	4	26	13.0	226	1495	
4400	3	45.4	5.0	11.1	7.69	6.3	4.8	4	35	12.6	239	1485	
4500	3	51.7	5.3	11.4	7.90	6.6	5.1	4	44	12.2	252	1475	
4600	3	58.0	5.6	11.7	8.10	7.0	5.3	4	53	11.8	265	1466	
4700	4	4.4	5.9	12.0	8.31	7.4	5.6	5	2	11.4	279	1456	
4800	4	10.9	6.2	12.4	8.52	7.8	5.8	5	12	11.1	293	1446	
4900	4	17.4	6.5	12.7	8.73	8.2	6.1	5	21	10.7	307	1436	
5000	4	24.0	6.8	13.0	8.94	8.6	6.4	5	31	10.4	322	1427	12.8
5100	4	30.7	7.1	13.3	9.15	9.0	6.7	5	41	10.1	337	1417	
5200	4	37.4	7.4	13.6	9.37	9.4	7.0	5	51	9.8	353	1408	
5300	4	44.2	7.7	13.9	9.59	9.9	7.3	6	1	9.5	370	1399	
5400	4	51.1	8.1	14.2	9.81	10.3	7.6	6	11	9.3	387	1389	
5500	4	58.0	8.4	14.6	10.03	10.8	7.9	6	21	9.0	404	1380	
5600	5	5.0	8.8	14.9	10.25	11.3	8.2	6	32	8.7	422	1371	
5700	5	12.1	9.2	15.2	10.47	11.8	8.5	6	43	8.5	441	1363	
5800	5	19.3	9.6	15.6	10.70	12.3	8.8	6	54	8.2	460	1354	
5900	5	26.5	10.0	15.9	10.92	12.8	9.2	7	5	8.0	480	1345	
6000	5	33.8	10.4	16.3	11.15	13.4	9.5	7	16	7.8	500	1337	11.7
6100	5	41.2	10.8	16.7	11.38	14.0	9.8	7	27	7.6	521	1329	
6200	5	48.7	11.3	17.0	11.60	14.6	10.2	7	39	7.4	542	1321	
6300	5	56.2	11.7	17.4	11.83	15.2	10.5	7	51	7.2	564	1313	

RANGE TABLE FOR 10-INCH B.L. RIFLE (STEEL).

Range.	Angle of departure. φ	For $\Delta C = \pm \frac{1}{10} C$ $\Delta\phi \pm$	For $\Delta V = \pm 50$ f. s. $\Delta\phi \mp$	Time of flight.	Drift.	Deviation for 10 miles of wind.	Fall: Angle of	Fall: Slope of	Maximum ordinate.	Striking velocity.	Penetration steel.
Yds.	° ′	″	″	sec.	Yds.	Yds.	° ′		ft.	f. s.	in.
6400	6 3.8	12.2	17.8	12.07	15.8	10.9	8 3	7.1	587	1305	
6500	6 11.5	12.7	18.2	12.30	16.5	11.2	8 15	6.9	610	1297	
6600	6 19.2	13.2	18.6	12.53	17.2	11.6	8 27	6.7	634	1290	
6700	6 27.0	13.7	19.0	12.77	17.9	11.9	8 40	6.6	653	1282	
6800	6 34.9	14.2	19.4	13.01	18.6	12.3	8 52	6.4	684	1275	
6900	6 42.9	14.8	19.9	13.25	19.3	12.7	9 5	6.2	710	1268	
7000	6 50.9	15.3	20.3	13.49	20.0	13.1	9 18	6.1	736	1261	
7100	6 59.0	15.9	20.8	13.73	20.7	13.5	9 31	6.0	763	1254	10.7
7200	7 7.1	16.4	21.3	13.98	21.5	13.9	9 45	5.8	791	1248	
7300	7 15.3	17.0	21.7	14.22	22.3	14.3	9 58	5.7	819	1241	
7400	7 23.6	17.6	22.2	14.47	23.1	14.7	10 12	5.6	848	1235	
7500	7 32.0	18.2	22.7	14.72	23.9	15.2	10 26	5.5	877	1229	
7600	7 40.5	18.8	23.2	14.97	24.8	15.6	10 40	5.3	908	1223	
7700	7 49.1	19.4	23.7	15.22	25.7	16.0	10 54	5.2	939	1217	
7800	7 57.7	20.0	24.2	15.48	26.6	16.5	11 8	5.1	971	1211	
7900	8 6.4	20.7	24.7	15.73	27.5	16.9	11 22	5.0	1004	1205	
8000	8 15.2	21.3	25.2	15.99	28.5	17.4	11 37	4.9	1037	1200	
8100	8 24.1	21.9	25.7	16.25	29.5	17.9	11 52	4.8	1071	1195	10.0
8200	8 33.1	22.6	26.2	16.51	30.5	18.4	12 7	4.7	1106	1190	
8300	8 42.1	23.3	26.7	16.78	31.5	18.8	12 22	4.6	1142	1185	
8400	8 51.2	24.0	27.2	17.04	32.6	19.3	12 37	4.5	1178	1180	
8500	9 0.4	24.6	27.7	17.30	33.7	19.8	12 52	4.4	1216	1175	
8600	9 9.7	25.4	28.3	17.57	34.8	20.3	13 8	4.3	1254	1170	
8700	9 19.1	26.1	28.8	17.84	35.9	20.8	13 24	4.2	1293	1166	
8800	9 28.5	26.8	29.3	18.11	37.1	21.3	13 39	4.2	1333	1161	
8900	9 38.0	27.5	29.9	18.38	38.3	21.8	13 55	4.1	1374	1157	
9000	9 47.6	28.3	30.4	18.65	39.5	22.3	14 11	4.0	1415	1153	9.4
9100	9 57.3	29.1	30.9	18.92	40.7	22.8	14 27	3.9	1457	1149	
9200	10 7.1	29.9	31.5	19.19	42.0	23.3	14 43	3.8	1500	1145	
9300	10 16.9	30.7	32.0	19.47	43.3	23.8	15 0	3.8	1545	1142	
9400	10 26.8	31.5	32.6	19.74	44.7	24.3	15 16	3.7	1590	1138	
9500	10 36.8	32.3	33.1	20.02	46.0	24.8	15 33	3.6	1636	1134	
9600	10 46.9	33.1	33.7	20.30	47.4	25.4	15 50	3.6	1683	1131	
9700	10 57.1	33.9	34.3	20.57	48.9	25.9	16 6	3.5	1731	1128	
9800	11 7.3	34.8	34.8	20.85	50.3	26.4	16 23	3.4	1779	1124	
9900	11 17.6	35.6	35.4	21.14	51.8	27.0	16 40	3.4	1829	1121	
10000	11 28.0	36.5	36.0	21.42	53.3	27.5	16 57	3.3	1880	1118	9.0
10100	11 38.5	37.4	36.6	21.70	54.9	28.0	17 14	3.2	1932	1115	
10200	11 49.1	38.2	37.2	21.99	56.4	28.6	17 31	3.2	1985	1112	
10300	11 59.8	39.1	37.8	22.28	58.1	29.2	17 49	3.1	2038	1110	
10400	12 10.5	40.0	38.4	22.57	59.7	29.7	18 6	3.1	2093	1107	
10500	12 21.3	40.9	39.0	22.86	61.4	30.3	18 24	3.0	2149	1104	
10600	12 32.2	41.9	39.6	23.15	63.2	30.9	18 42	3.0	2205	1102	
10700	12 43.1	42.8	40.2	23.44	64.9	31.4	18 59	2.9	2263	1100	
10800	12 54.1	43.7	40.9	23.74	66.7	32.0	19 17	2.9	2322	1097	
10900	13 5.2	44.7	41.5	24.03	68.5	32.6	19 35	2.8	2381	1095	
11000	13 16.4	45.7	42.1	24.33	70.4	33.2	19 53	2.8	2442	1093	
11100	13 27.7	46.7	42.7	24.63	72.3	33.8	20 11	2.8	2504	1091	8.7
11200	13 39.0	47.7	43.3	24.93	74.2	34.4	20 29	2.7	2566	1089	
11300	13 50.4	48.8	44.0	25.23	76.2	35.0	20 48	2.7	2630	1087	
11400	14 1.9	49.8	44.6	25.53	78.2	35.6	21 6	2.6	2695	1085	
11500	14 13.5	50.8	45.2	25.84	80.3	36.2	21 24	2.6	2761	1084	
11600	14 25.1	51.9	45.9	26.14	82.4	36.8	21 43	2.6	2828	1082	
11700	14 36.8	53.0	46.5	26.45	84.5	37.4	22 1	2.5	2896	1080	
11800	14 48.6	54.1	47.1	26.76	86.7	38.0	22 20	2.5	2965	1079	
11900	15 0.4	55.2	47.8	27.07	88.9	38.7	22 38	2.4	3036	1077	
12000	15 12.3	56.3	48.4	27.38	91.2	39.3	22 57	2.4	3107	1076	8.5

BOOK REVIEWS.

Lectures on Explosives. Willoughby Walke, First Lieutenant, Fifth United States Artillery Instructor U. S. Artillery School. Second Edition. New York: John Wiley & Sons. 1897.

The course of lectures prepared by Lieutenant Walke as a manual and guide in the practical laboratory work in the course of explosives at the U. S. Artillery School, has been officially adopted for the examination of officers of artillery for promotion, and so has received the stamp of authority. While most of the volume is compilation, the author has spared no pains in his description of processes of manufacture, to obtain the latest and fullest information on the subject, and in that respect the work is exceedingly satisfactory. The articles on densimetry, analysis of explosives and the service tests are all standard, and leave nothing to be desired. Certain improvements in the classification of explosives could be suggested, but as the author himself recognizes this fact, and has the changes under consideration, it is not necessary for us to make any remarks on that subject here.

The first point for criticism that would strike the chemical student familiar with the literature of the subject would probably be the excessive and free use made of Professor C. E. Munroe's *Lectures on Chemistry and Explosives*, Cundill's *Dictionary of Explosives*, and other works, and the slight acknowledgement made to these aids in compliation. Page after page, and even entire chapters, have been taken from Professor Munroe's work with the alteration of scarcely a word or a phrase, although some general remarks give this author credit therefor; and the description of a considerable number of explosives has been copied almost word for word from Major Cundill's work without any acknowledgement whatever.

The second point for criticism is the apparent looseness of the explanations of chemical actions in certain cases. We will consider the more important of these, in order.

It is but fair to state, however, that the author has corrected most of errors in the text at the beginning of the course with the class of officers, and we merely refer to them here in order to assist readers of the work.

P. 87, last paragraph: After the more or less full explanation of the principles involved in large-grained powders, it seems a little unfair to dismiss the action of perforated powders with the simple remark: "Perforations were found necessary to insure better and more uniform control of combustion in the grain," and without adding another word of explanation.

Page 99, paragraph three: The explanation of the effect of dissociation is really no *explanation* at all, and the whole paragraph had better be omitted. In the first place, it is very doubtful if the dissociation of water-vapor comes into play at all; and in the second place it is not necessary to consider it, because it can play but a secondary part, since water vapor decomposes only at a very high temperature and we know very little of the actual temperature in the bore of a gun, and still less of the temperature of dissociation of water vapor *under the pressure existing*. Moreover, there are other substances

present (carbohydrates, for example) which decompose very readily, and their effect will far exceed that of water vapor.

Page 100, paragraph three: We fail to grasp the point which the author intends to make here. When carbohydrates are heated, besides the water vapor, compounds of carbon, hydrogen and oxygen are often given off, and some of these may contain a smaller proportion of hydrogen than is necessary to form water with the oxygen, consequently some hydrogen (still combustible) would be left with the carbon. But what has this to do with the explanation of the action of brown powders?

Page 155, last paragraph: The author does not appear to recognize the fact that, although in the nitrates only five-sixths of the oxygen is available for combustion, and in the chlorates all the oxygen is so available, nevertheless, a given weight of a nitrate furnishes *more* oxygen for combustion than the same weight of the corresponding chlorate.

Pages 105 and 106: In both structural formulæ the author gives us $C_{18}\,H_{36}\,O_{18}$, although he intends to give us the structural formula of $C_{18}\,H_{30}\,O_{15}$.

Page 297, paragraph two: The author *assumes* a reaction for the explosion of a mixture of guncotton and potassium nitrate, and then speaks of "the amount of guncotton required by theory," as if any theory had anything to do with it! Every variation in the proportions of the ingredients must occasion a change in the reaction of explosion.

Page 327, paragraph three: The fact that a smokeless powder gives off "noxious and irrespirable gases when exploded" certainly does *not* interfere with its use as a *military* explosive.

Pages 359 and 360: The explanation of the brusqueness of the action of pure mercury fulminate alone, as well as its action as compared with that of a mixture of the same with potassium nitrate, is entirely inadequate. The first is evidently due to the *rapidity of the chemical reaction*, which no one has as yet attempted to explain; the second may be explained by the fact that the particles of potassium nitrate *separate* the particles of the fulminate, and so dilute the latter and delay the chemical action. However, if dissociation does come into play (which is very doubtful, as far as explaining the difference in brusqueness is concerned) it will be the potassium carbonate, rather than the carbon dioxide, which will undergo this change.

Page 369, last paragraph: Defining diazo-benzene nitrate as "the residue of two nitrogenized bodies, etc.," is merely quoting a poor translation from the French, which does not fully bring out the original meaning. To any one who understands the general principles involved in explosive compounds the mere symbol would have shown the explosive character of the compound much better than the paragraph here referred to.

There are also a few minor points that call for remark:

Page 4, paragraph one: The velocity of propagation of the explosion of gunpowder in the open air is given as "4 feet per second," whereas Piobert (the authority usually quoted) gives it as *four-tenths of an inch per second.*

Page 168, paragraph five: The statement that "the nitro-compounds are less energetic in their action and more stable than the nitric ethers," is somewhat weakened by the reference, on p. 202, to "the greater stability and energy of nitric derivatives."

Page 215: The discussion of Vielle's formulas for the various grades of nitrocottons should inform the readers that his views have not as yet been generally accepted by the chemical world, indeed, most chemists still hold to Eder's views.

Page 285, last paragraph: What follows from this point on should have a new heading; as it stands it comes under the preceeding heading, with which it has nothing to do.

Lieutenant Walke's work is essentially a manual and guide for practical work in the laboratory, and the explanation of the phenomena of explosion is not a necessary part of it; still, as the author evidently regarded this as of some importance to the student, and therefore embodied it in his book, the latter should be clear and accurate in its statements relating to these phenomena.

We have been thus careful to point out small errors, which would hardly be noticed in a review ordinarily, because this work is a standard for the examination and instruction of officers, and for that reason all such errors should be eliminated. We point them out, not with any intention of merely finding fault but with a sincere desire to assist the author and publisher in improving their work, which has done excellent service in the laboratory of the Artillery School, and will be of great value to the army at large.

The general arrangement of the work is excellent, and the publishers have done their part well. J. P. W.

The Naval Annual, 1898. Edited by T. A. Brassey. Portsmouth: J. Griffin & Co., 2, The Hard.

This valuable publication, the best authority on the subject of the world's navies in the English language, appears once more and very opportunely. The special features of the present volume are an account of the Russian Navy, Sir George Clark's treatise on naval scouting, Commander Robinson's article on Naval Reinforcements in War Time, and Mr. Gleig's discussion of the question of food supply in war time.

The other information regarding the British navy and foreign navies is as complete and reliable as it can well be made.

The next number is to contain an account of the navy of the United States. What we have said in our review of the last volume (1897) applies, in general, to this, and we can only add that as a publication it becomes every year more indispensable to all navy and sea-coast artillery officers. J. P. W.

Petit Dictionnaire Militaire Français-Allemand et Allemand-Français par W. Stavenhagen. Première Partie: Français-Allemand. Berlin: Librairie Militaire de R. Eisenschmidt. 1897.

The ordinary dictionaries are quite inadequate for the military student in these days of enormous progress in all branches of military art and science, hence the necessity for a special work that shall take account of the vocabulary which this great development has added to literature of late years.

The little volume is intended primarily for the use of military men, but it will also find a welcome place in the library of the general reader, for the new words of technical military writers gradually creep into general literature.

The definitions are clear and concise, and the volume is printed and bound in convenient form for practical use. J. P. W.

Kriegsgeschichtliche Beispiele aus dem deutsch-fransösische Kriege von 1870-71. Kunz, Major a. D. Sechtes und Siebentes Heft. Berlin: E. S. Mittler und Sohn. M. 1.60 und 1.40.

The German field artillery, in 1870-1, established the principles on which are based our present ideas of the use of field artillery in battle. The two present numbers of this series of examples from the Franco-German war relate entirely to the use of field artillery, and since the German field artillery

had a wide and varied experience, these examples are full of val. able lessons and interesting matter.

As an example of the modern method of massing artillery, the battle of Sedan was taken. Here 155 batteries were concentrated, of which 116 came into full action, 22 only partially (each firing less than 120 shots) and 17 did not fire at all. The entire artillery force available was, therefore, not required in bringing about a catastrophe such as no army had ever before suffered.

The surprise and attack of French camps by artillery is illustrated from the battles of Vionville, Amanvillers and Beaumont; and the part played by field artillery in the attack of French fortifications by instances taken from twenty-one different battles.

Important tactical questions, such as the near approach of the artillery to the enemy, the effect of flank fire and the weakness of the artillery flanks, and finally the preparation for the infantry attack on fortified positions or villages are illustrated and discussed in a thorough and masterly way.

Each of these numbers has appended a collection of problems based on the principles set forth and the situations cited.

As studies for the light artillery officer these example are invaluable, and we are pleased to note that the reception accorded to this collection by the military world has more than met the author's expectations.

J. P. W.

Die Heere und Flotten der Gegenwart. I. Deutschland. Herausgegeben von Professor Dr. J. von Pflugh-Harttung. Berlin: Schall und Grund.

A superb work, grand in design and elegant in execution. The interesting subject of the war power of Germany is presented in a most attractive form in this volume, and succeeding volumes will contain accounts of the other great armies and navies of the world, generally written by the most prominent men in the professions concerned. In the present volume the army is treated by Lieutenant-General v. Boguslawski, one of the foremost military writers of Germany, and the navy by Admiral Aschenborn of the Imperial German Navy. The authors are a guarantee of the excellence of the work, and since the publishers have spared no pains in making the illustrations as accurate and artistic as the subject-matter is interesting and reliable, the entire work stands unrivalled in the field it covers.

The account of the army opens with an historical introduction, then takes up the general military system, the organization of the army and its various branches, its mobilization, instruction, armament, equipment and clothing; continues with a spirited description of service in the army, an interesting and masterly summary of the changes in tactics to the present, an account of the service in the field and the attack and defence of fortifications and a description of the various military schools for officers and men; and closes with a full and accurate presentation of the medical, pay, quartermaster, commissary and other departments, and a brief essay on the moral factors in the army. To this are appended tables giving the constitution and location of all the subdivisions of the army.

The navy is pictured in a similar way.

The illustrations (many in colors) present the flags, uniforms, arms, guns, ships, bridge trains, and equipments, besides portraits of the most prominent commanders.

Altogether it is a book worth possessing by all who desire an acquaintance

with the most perfect army the world has ever seen, and a navy that is fast attaining a high rank among the great navies of Europe.

J. P. W.

Recueil des Travaux Techniques des Officiers du Génie de l'Armée Belge. I. 1897. Ixelles: Inspector-General's Office.

Belgium has stood at the head of the profession of military engineering for a number of years, and General Brialmont still holds his place as the foremost military engineer of the world, while Captain Deguise, instructor in the course of fortification at the Brussels school of application, ranks high among the lesser lights.

The purpose of this collection of essays is to present the views of experts in various lines of thought for the benefit of the officers of the Belgian engineers. The publication committee is presided over by the Inspector-General of the army, and absolute freedom of thought is guaranteed. Articles by foreign engineer officers are also admitted.

The opening article is by General Brialmont on the organization of permanent intrenched camps, and it is not unteresting to note his introductory remarks:

"The advantages of and necessity for permanent intrenched camps has been recognized by the most distinguished generals and engineers of the century, and disputed by only a small number of critics, who have drawn false conclusions from the long resistance of Plevna and the destructive effects of torpedo shell. Hence, the subject is now limited to the consideration of the organization of intrenched camps, their character and the disposition of their works.

"Some engineers propose a girdle of forts without a central continuous enceinte, and cite in support of their proposition the intrenched camps of Reims, Epinal, Dijon, Bucharest and Copenhagen, constructed since the Franco-German war: but they lose sight of the fact, or deliberately ignore it, that the plans for the four first mentioned call for a closed interior work, but its construction has simply been postponed on account of the insufficiency of the appropriations, or from the necessity of meeting more urgent demands. The fifth, that of Copenhagen, is a peculiar case, as it is designed merely to resist a bombardment from the sea, either alone or combined with an assault by a landing party.

"As soon as the Danish government finds that the capital should be able to resist a regular siege, it will no longer hesitate to replace the old encenite, of which only the citadel is left, by a more extended enceinte forming a second line of defense."

The article discusses the subject in the author's usual masterly style, and with the two excellent plates illustrating it constitutes a little classic on the subject.

The second essay, by Captain of Engineers E. Cavelier, professor at the military academy, considers the relations of geology to the engineer's art. Other articles treat of the attack and defense of fortified places, the increased protection required in field fortifications, the rapid construction of mines, etc., and the volume closes with Captain Deguise's observations on the organization of the principal line of defense in fortresses of large development, another classic on the subject considered.

The plates leave nothing to be desired, and the entire work is a credit to this nation of military engineers.

J. P. W.

Descriptive General Chemistry, a text book for a short course, by S. E. Tillman, Professor of Chemistry, Mineralogy and Geology, United States Military Academy. West Point, N. Y., U. S. M. A. Press., 1897.

The appearance of a new text-book on chemistry, in view of the great number of such works already in use, seems to require some explanation.

The object of the course at the military academy is principally to teach so much of the subject as is necessary for the education of a gentleman, and secondarily to lay the foundation for the few who may be called upon in service to develop the subject further. Hence, the essential principles must first be established, and these must be followed by a description of the great chemical processes used in the world's manufactures. Now, no text-book combines these two in a satisfactory way to meet the demands of a course that is necessarily short, having in view the object above stated. Many are excellent on the subject of the principles of chemistry, and quite a number are sufficiently full on the applications to the arts and manufactures. The present work aims to combine the two in such a way as to meet the demands of the institution, the purpose of which is to prepare officers and not chemists.

"The matter embraced is the result of more than sixty years' selection and sifting made in the effort to secure that most essential and important for this course." (Preface).

The work is at present used only at the military academy, but when it is given to a publisher and made available elsewhere it should meet with a hearty welcome from all institutions in which the object is similar to that at West Point, viz: to give a general course of instruction in chemistry as a factor in general education. No better book for this purpose is in the market today.

J. P. W.

Die Lehre vom Schuss und die Schusstafeln. Heydenreich, Captain, Saxon Field Artillery Regiment No. 12, member of the Artillery Examining Board. Berlin: E. S. Mittler und Sohn. 1898. 6 marks.

This new work on artillery fire and range tables is the text-book in ballistics at the Artillery and Engineer School near Charlottenberg, and constitutes a supplement to the firing regulations of the artillery. In 1887 the separate sections of the old artillery manual were re-written and issued to the army as separate pamphlets. The author of the present work was detailed by the War Department to the Artillery Examining Board to write up the subject of ballistics. It is not designed to be a scientific treatise, but essentially a military handbook, consequently expressions involving the higher mathematics have been carefully avoided, in order to make the work accessible to all.

The book is divided into two parts, corresponding to the two years at the school of application above referred to. Part I contains the general principles at the foundation of the science, followed by a discussion of the subject of range tables, their arrangement, computation and practical use and value. Part II comprises the elements of interior and exterior ballistics.

The general principles contain nothing new, the purpose of this section being to refresh the memories of such officers as have not had occasion to study the subject of ballistics for some time.

The range tables are considered in a general way, taking up their purpose, their arrangement (with models of range tables for various projectiles), their practical use, with problems relating to deviation, the depth of action of shrapnel, the effects of torpedo shell, their computation, and finally their

value in practice. An interesting section relates to firing at balloons and firing without *observing* the effects.

The subject of interior ballistics contains a very thorough discussion of the influence of size and form of grain, of space in which combustion takes place, of weight of charge, and of weight of projectile, on the rate of combustion, besides the influence of the mode of combustion on the accuracy.

Under exterior ballistics the usual matters are considered, and the work concludes with tables of the various factors of the ballistic tables, arranged for convenience in colors, the pages of each table having a different color, so that it can be quickly found. J. P. W.

Der Kampf um Kuestenbefestigungen von Sigmund Mielichhofer, k. u. k. Hauptmann im Festungs-Artillerie-Regimente No. 5. Wien und Leipzig: Wilhelm Braumueller. 1897. 2 Mark.

This work is the first attempt to bring together in a single book all that is known and generally accepted on the subject of the defensive organization of sea-coast forts, their attack and defense.

The author (a Captain in the Austrian Fortification Artillery) has devoted much time and study to the subject, and the articles he has published from time to time have been well received.

The lack of a good and complete work on this subject has prevented many officers from applying themselves to the study of the questions involved, questions that are of vital importance to the artillery, and one of the purposes of the present volume is to overcome this difficulty.

The author discusses first the *value* of sea-coast fortifications, and then takes up the *means* of attack and defense, including, first, those common to both: such as the floating material, the ram, artillery, the torpedo, the torpedo net, the search light, etc.; second, the special means for defense: such as sea-coast artillery, fortifications, range finders, obstructions, the electric light, etc.

After a short discussion of the preparations necessary for coast defenses, illustrated by an example of an actual harbor properly prepared for defense, with all the accessories, the author considers the different modes of attack, viz: blockade, bombardment and attack by sea, the last comprising the removal of the outer obstructions, reconnoitering the artillery of the defense, attack by artillery on the works protecting the entrance, reconnoitering and removing the inner obstructions, and the forcing of the entrance. The illustrations are the forcing of the entrance to the Mississippi in 1862, and to Mobile Bay in 1864, both of which are still models for the action of the world's navies, as shown by Commodore Dewey's splendid action at Manila.

Landing operations are next considered, and these are illustrated by Wei-hai-Wei in 1895.

The consideration of the measures of the defense against these different modes of attack forms the closing chapter of the work.

The subject-matter is treated with great clearness, conciseness, system and thoroughness, and the entire work is worthy of careful study by the artillery officer. J. P. W.

BOOK NOTICES.

[These books will be fully *reviewed* as space becomes available.]

Der deutsche Besitz in Schantung von H. von Bülow, Leipzig: Verlagsanstalt Militärische Rundschau. 1898.

The Engineering Magazine. New York: 120 Liberty street.

We desire to call special attention to the *Engineering Index* of this valuable publication.

Catechismal Edition of the Infantry Drill Regulations United States Army. Extended Order. Prepared by Major Wm. F. Spurgin, 23rd Infantry. Kansas City, Mo.: Hudson-Kimberly Publishing Co. Price: Tag board cover, 25 cents, blue cloth, 50 cents.

Privates' Handbook of Military Courtesy and Guard Duty by Lieut. Melvin W. Rowell, United States Army. Kansas City, Mo.: Hudson-Kimberly Publishing Co. Price: Tag board cover, 25 cents, blue cloth, 50 cents.

Manual for Cyclists for the use of the Regular Army, Organized Militia, and Volunteer Troops of the United States. By Captain Howard A. Giddings, Brigade Signal Officer, Connecticut National Guard. Kansas City, Mo.: Hudson-Kimberly Publishing Co. Price: Full blue cloth, illustrated, 75 cents.

Inquiries into the Tactics of the Future. Fritz Hoenig. Translated by Carl Reichmann, First Lieutenant, 9th Infantry. International Military Series, No. 6. Kansas City, Mo.: Hudson-Kimberly Co. Price: Full blue cloth, \$2.00.

INDEX TO CURRENT ARTILLERY LITERATURE.

PERIODICALS CITED.

Abbreviations employed in index are added here in brackets.

All the periodicals are preserved in the Artillery School Library, Fort Monroe, Virginia.

ENGLAND.

Aldershot Military Society. *Occasional.*
Aldershot. Copies 6d each.

Arms and Explosives. [*Arms and Ex.*] *Monthly.*
Effingham House, Arundel Street, Strand, London, W.C. Per year 7 s.

Army and Navy Gazette. [*A. and N. Gaz.*] *Weekly.*
3 *York Street, Covent Garden, London. Per year £*1 12 *s* 6 *d.*

Canadian Military Gazette. [*Can. Gaz.*] *Fortnightly.*
Box 2179 *Montreal, Canada. Per year* $2.00.

The Engineer. [*Eng.*] *Weekly.*
33 *Norfolk Street, Strand, London. Per year £*2 6 *d.*

Engineering. [*Eng'ing.*] *Weekly.*
35-36 *Bedford Street, Strand, London, W. C. Per year £*2 6 *d.*

Journal of the Royal United Service Institution. [*Jour. R. U.S.I.*] *Monthly.*
17 *Great George Street, London, S. W. Per year* 24 *s.*

Journal of the United Service Institution of India. [*Jour. U. S. I. India*] *Quarterly.*
Simla, India. Per year $2.50.

Photographic Journal. [*Photo. Jour.*] *Monthly.*
12 *Hanover Square, London.*

Proceedings of the Institution of Civil Engineers. [*Proceedings I. C. E.*]
25 *Great George Street, Westminister, London.*

Proceedings of the Institution of Mechanical Engineers.
[*Proceedings I. M. E.*] 19 *Victoria Street, Westminister, London.*

Proceedings of the Royal Artillery Institution. [*Proceedings R. A. I.*] *Monthly.*
Woolwich, England.

Professional Papers of the Corps of Royal Engineers.
[*Prof. Papers Corps Royal Eng'rs.*]
Chatham, England.

Review of Reviews. [*Rev. of Rev. Austral.*] *Monthly.*
169 *Queen Street, Melbourne, Australia. Per year* 11 s. 6 d.

Transactions of the Canadian Institute. [*Trans. Canadian Inst.*]
58 *Richmond Street, Toronto, Canada.*

Transactions of the Canadian Society of Civil Engineers.
[*Trans. Canadian Soc. C. E.*]
Montreal, Canada.

Transactions of the East of Scotland Tactical Society.
[*Trans. E. of S. Tactical Soc.*]
51 *Hanover Street, Edinburgh, Scotland.*

Transactions of the Institute of Naval Architects.
[*Trans. Inst. Naval Architects.*]
5 *Adelphi Terrace, London, W.C.*

United Service Gazette. [*U. S. Gaz.*] *Weekly.*
4-6 *Catherine Street, Strand, London, W.C. Per year* £1 10*s* 6*d.*

FRANCE.

L'Avenir Militaire. [*Avenir.*] *Semi-weekly.*
13 *Quai Voltaire, Paris. Per year* 18 *Fr.*

Le Génie Civil. [*Génie C.*] *Weekly.*
6 *Rue de la Chaussée d'Antin, Paris. Per year* 45 *Fr.*

Journal des Sciences Militaires. [*Sciences Militaires.*] *Monthly.*
Rue et Passage Dauphine 30, *Paris. Per year* 40 *Fr.*

La Marine Française. [*Marine F.*] *Semi-monthly.*
23 *Rue Madame, Paris. Per year* 30 *Fr.*

Mémoires et Compte Rendu des Travaux de la Société des Ingénieurs Civils.
[*Ingénieurs Civils.*] *Monthly.*
10 *Cité Rougemont, Paris. Per year* 36 *Fr.*

Mémorial des Poudres et Salpêtres. [*M. Poudres et S.*] *Quarterly.*
Quai des Grands-Augustins, 55, *Paris. Per year* 12 *Fr.*

Le Monde Militaire. [*Monde.*] *Fortnightly.*
76 *Rue de Seine, Paris. Per year* 6 *Fr.*

Revue d'Artillerie. [*R. Artillerie.*] *Monthly.*
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Berger Levrault et Cie, Rue des Beaux-Arts 5, *Paris. Per year* 33 *Fr.*

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L. Baudoin, Rue et Passage Dauphine 30, *Paris. Per year* 56 *Fr.*

Revue Militaire de l'Etranger. [*Etranger.*] *Monthly.*
L. Baudoin, Rue et Passage Dauphine 30, *Paris. Per year* 15 *Fr.*

Revue Militaire Universelle. [*R. Univ.*] *Monthly.*
11 *Place Saint André-des-Arts, Paris. Per year* 25 *Fr.*

Le Yacht—Journal de la Marine. [*Yacht.*] *Weekly.*
55 *Rue de Chateaudun, Paris. Per year* 30 *Fr.*

GERMANY.

Allgemeine Militaer-Zeitung. [*A. M.-Zeitung.*] *Semi-weekly.*
Darmstadt. Per year 24 *M.*

Archiv fuer die Artillerie-und Ingenieur Offiziere. [*Archiv.*] *Monthly.*
Koch Strasse, 68-78, *Berlin*, *S. W.* 12. *Per year* 12 *M.*

Beiheft zum Militaer-Wochenblatt. [*Beiheft.*]
Koch Strasse, 68, *S. W.*, *Berlin.*

Deutsche Heeres-Zeitung. [*Heeres-Zeit.*] *Semi-weekly.*
Wilhelmstrasse 15, *Berlin.* *Per year* $6.00.

Internationale Revue. [*Int. Revue.*] *Monthly.*
Blasewitzer Strasse 15, *Dresden.* *Per quarter* 6 *M.*

Jahrbuecher fuer die deutsche Armee und Marine. [*Jahrbuecher.*] *Monthly.*
Mohren Strasse, 19, *Berlin*, *W.* 8. *Per year* 32 *M.*

Kriegstechnische Zeitschrift. [*Kriegstech.*] *Ten numbers a year.*
Koch Strasse, 68-71, *Berlin.* *Per year* 10 *M.*

Kriegswaffen. [*Kriegswaffen.*] *Monthly.*
Rathenow, *Germany.* *Per year* $4.50.

Marine Rundschau. [*Mar. Rundschau.*] *Monthly.*
Koch Strasse, 68-70, *Berlin.* *Per year* 3 *M.*

Militaer-Wochenblatt. [*Wochenblatt.*] *Semi-weekly.*
Koch Strasse, 68, *Berlin*, *S. W.* 12. *Per Year* 20 *M.*

Militärische Rundschau. [*Mil. Rundschau.*] *Occasional.*
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Stahl und Eisen. [*Stahl u. Eisen.*] *Fortnightly.*
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Umschau, Die. [*Umschau.*] *Weekly.*
Frankfort a. M. *Per year* 10 *M.*

AUSTRIA.

Mittheilungen ueber Gegenstaende des Artillerie und Genie-Wesens.
[*Mitth. Art. u. G.*] *Monthly.*
Wien, *VI*, *Getreidemarkt* 9. *Per year* 1 *Fl.* 50 *Kr.*

Mittheilungen aus dem Gebiete des Seewesens. [*Seewesens.*] *Monthly.*
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Organ der Militaer Wissenchaftlichen Vereine. [*Vereine.*]
Wien I, *Stauchgasse No.* 4. *Per year*, 8-14 *numbers*, 6 *Fl.*

Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines.
[*Z. Architekten Vereines.*] *Weekly.*
I. Eschenbachgasse, *No.* 9, *Wien.* *Per year* 10 *Fl.*

SWITZERLAND AND BELGIUM.

Allgemeine Schweizerische Militaer-Zeitung. [*A.S.M. Zeitung.*] *Weekly.*
Basel, *Switzerland.* *Per year*, 8 *Fr.*

La Belgique Militaire. [*Belgique M.*] *Weekly.*
Rue St. Georges 32, *Ixelles*, *Belgium.* *Per year* 12.50 *Fr.*

Monatschrift fuer Offiziere Aller Waffen. [*Monatschr.*] *Monthly.*
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Revue de l'Armèe Belge. [*A. Belge.*] *Bi-monthly.*
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Revue Militaire Suisse. [*R. M. Suisse.*] *Monthly.*
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Schweizerische Zeitschrift fuer Artillerie und Genie. [*S. Zeitschrift.*]
Monthly.
Frauenfeld, Switzerland. Per year 8 *Fr.* 20 *centimes.*

SPAIN, PORTUGAL AND SOUTH AMERICA.

Boletin del Centro Naval. [*Boletin.*] *Monthly.*
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Circulo Naval,—Revista de Marina. [*R. de Marina.*] *Monthly.*
Casilla num. 852, *Valparaiso, Chili.*

Memorial de Artilleria. [*M. de Art.*] *Monthly.*
Farmacia, num. 13, *Madrid, Spain. Per year, U. S.,* $3.40.

El Porvenir Militar. [*Porvenir.*] *Weekly.*
258 *Calle Montevideo, Buenos Aires, Argentina. Per year* 10 $ $\frac{m}{n}$.

La Prensa Militar. [*Prensa.*] *Weekly.*
Reconquista 1034, *Buenos Aires, Argentina.*

Revista Cientifico-Militar. [*Cientifico M.*] *Semi-monthly.*
5 *Calle de Cervantes, Barcelona, Spain. Per year* 32 *Fr.*

Revista da Commissao Technica Militar Consultiva. [*R. da Commissao.*]
Bi-monthly. Praça da Republica N. 32, *Rio de Janeiro, Brasil.*

Revista de Engenheria Militar. [*Engenheria Mil.*] *Monthly.*
27 *Rua Nova do Almada, Lisbon, Portugal. Per year* 1 $ 800 *réis.*

Revista do Exercito e da Armada. [*Exercito.*] *Monthly.*
Largo de S. Domingos No. 11, *Lisbon, Portugal. Per year U. S* $6.00.

Revista General de Marina, [*R. G. de Marina.*] *Monthly.*
56 *Calle de Alcalá, Madrid, Spain. Price U. S.* $4.45.

Revista Maritima Brazileira. [*R.M. Brazil.*] *Bi-monthly.*
Rue do Conseheiro Saraiva n. 12, *Rio de Janeiro, Brazil. Per year* $10.00.

Revista Militar. [*R. Mil. Portugal.*] *Semi-monthly.*
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Revista Militar. [*R. Mil. Chile.*] *Monthly.*
Santiago, Chili.

HOLLAND AND SCANDINAVIA.

Artillerie-Tidskrift. [*Art. Tids.*] *Bi-monthly.*
Stockholm, Sweden. Per year, U. S., $1.75.

De Militaert Gids. [*M. Gids.*] *Bi-monthly.*
De Erven F. Bohn, Haarlem, Holland. Per year, U. S., $2.00.

Militaert Tidsskrift. [*M. Tids.*] *Bi-monthly.*
Copenhagen, Denmark. Per year, U. S., $2.50.

Norsk Militeert Tidsskrift. [*N. M. Tids.*] *Monthly.*
Christiania, Norway. Per year, U. S., $2.50.

RUSSIA.

Artilleriiskii Journal. [*Art. Journal.*] *Monthly.*
Furschtatskaia Ulitza, St. Petersburg, Russia.

Razviedchik. [*Razv.*]
KoloKolwaia Ulitza, No. 14, *St. Petersburg, Russia.*

Russkii Invalide. [*Invalide.*]
Wadizdinskia Ulitza, No. 48, *St. Petersburg, Russia.*

ITALY.

Rivista di Artiglieria é Genio. [*R. Artig.*] *Monthly.*
Tipografia Voghera Enrico, Rome. Per year 30 *L.*

Rivista Marittima. [*R. Maritt.*] *Monthly.*
Rome. Per year 25 *L.*

UNITED STATES.

American Engineer and Railroad Journal. [*Eng. and Rail. Jour.*] *Monthly.*
140 *Nassau Street, New York City. Per year* $2.00.

American Journal of Mathematics. [*Jour. Math.*]
John Hopkins University, Baltimore, Md.

American Machinist. [*Amer. Mach.*] *Weekly.*
256 *Broadway, New York City. Per year* $3.00.

American Manufacturer and Iron World. [*Man. and Iron World.*] *Weekly.*
59 *Ninth Street, Pittsburgh, Pa. Per year* $4.00.

Annual of the Office of Naval Intelligence. [*Naval Intelligence.*]
Washington, D. C.

Army and Navy Journal. [*A. and N. J.*] *Weekly.*
New York City. Per year $6.00.

Army and Navy Register. [*A. and N. R.*] *Weekly.*
Washington, D. C. Per year $3.00.

Bulletin of the American Mathematical Society. [*Bulletin Math. Soc.*]
University Heights, New York City.

Cassier's Magazine. [*Cas. Mag.*] *Monthly.*
3, *West* 29*th Street, New York City. Per year* $3.00.

Digest of Physical Tests. [*Digest.*] *Quarterly.*
1424 *N.* 9*th Street, Philadelphia. Per year* $1.00.

Electrical Engineer. [*Elec. Eng.*] *Weekly.*
203 *Broadway, New York City. Per year* $3.00.

Electrical Engineering. [*Elec. Eng'ing.*] *Semi-Monthly.*
443 *The Rookery, Chicago, Ill. Per year* $1.00.

Electrical Review. [*Elec. Rev. N. Y.*] *Weekly.*
41 *Park Row, New York City. Per Year* $3.00.

The Engineer. [*Eng. N. Y.*] *Fortnightly.*
106-108 *Fulton Street, New York City. Per year* $2.50.

Engineering Magazine. [*Eng'ing. Mag.*] *Monthly.*
120-122 *Liberty Street, New York City. Per year* $3.00.

Engineering News and American Railroad Journal.
[*Eng'ing News and R.R. Jour.*] *Weekly.*
220 *Broadway, New York City. Per year* $5.00.

Engineering and Mining Journal. [*Eng. and Min. Jour.*] *Weekly.*
253 *Broadway, New York City. Per year* $5.00.

The Iron Age. [*Iron Age.*] *Weekly.*
96-102 *Reade Street, New York City. Per year* $4.50.

Journal of Electricity. [*Jour. Elec.*] *Monthly.*
421 *Market Street, San Francisco, Cal.*

Journal of the American Chemical Society. [*J. Chem. S.*] *Monthly.*
Easton, Pa. Per year $5.00.

Journal American Society of Naval Engineers. [*A.S.N. Egrs.*] *Quarterly.*
Navy Department, Washington, D. C.

Journal of the Association of Engineering Societies. [*Eng. Soc.*] *Monthly*
257 *South Fourth Street, Philadelphia. Per year* $3.00.

Journal of the Franklin Institute. [*Frank. Inst.*] *Monthly.*
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Journal of the Military Service Institution. [*Jour. M. S. I,*] *Bi-monthly.*
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Journal of the U.S. Cavalry Association. [*Jour. U. S. Cavalry*] *Quarterly.*
Fort Leavenworth, Kansas.

Journal of the Western Society of Engineers. [*W. Soc. Eng.*] *Bi-monthly.*
1737 *Monadnock Block, Chicago, Illinois. Per year* $2.00.

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Military Information Division. [*Mil. Information Div.*] *Occasional.*
War Department, Washington, D. C.

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Pennsylvania Magazine of History and Biography. [*Penn. Mag. of Hist.*] *Quarterly.*
13 *Locust Street, Philadelphia. Per year* $3.00.

The Photographic Times. [*Phot. Times.*] *Weekly.*
60 *and* 62 *E.* 11*th Street, New York City. Per year* $5.00.

Physical Review. [*Phys. Rev.*] *Bi-monthly.*
Cornell University, Ithaca, New York. Per year $3.00.

Popular Science Monthly. [*Pop. Sc. Mo.*] *Monthly.*
72 *Fifth Avenue, New York City. Per year* $5.00.

Proceedings of the American Philosophical Society.
[*Proceedings of A. Phil. Soc.*]
104 *South Fifth Street, Philadelphia, Pa.*

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Annapolis, Md. Per year $3.50.

Public Opinion. [*Pub. Opin.*] *Weekly.*
New York City. Per year $2.50.

Review of Reviews. *Monthly.*
13 *Astor Place, New York City. Per year* $2.50.

The Scientific American. [*Scien. Amer.*] *Weekly.*
361 *Broadway, New York City. Per year* $3.00.

Shooting and Fishing. *Weekly.*
293 *Broadway, New York City. Per year* $3.50.

Technology Quarterly. [*Tech. Quart.*] *Quarterly.*
Mass. Inst. of Tech., Boston, Mass. Per year, $3.00.

Transactions American Institute of Electrical Engineers.
[*Inst. Elec. Eng'rs.*] *Monthly.*
26 *Cortlandt Street, New York City. Per year* $5.00.

Transactions American Institute of Mining Engineers.
[*Trans. Inst. Min. Eng'rs.*]
P. O. Box 225, *New York City.*

Transactions of the American Society of Civil Engineers.
[*Trans. A. S. Civil Eng'rs*]
220 *West* 57*th Street, New York City.*

Transactions of the American Society of Mechanical Engineers.
[*Trans. A. S. Mech. Eng'rs.*]
12 *West* 31*st Street, New York City.*

Transactions of the Society of Naval Architects and Marine Engineers.
[*Naval Architects and Marine Eng'rs.*]
12 *West* 31*st Street, New York City.*

Western Electrician. [*West. Elec.*] *Weekly.*
510 *Marquette Building, Chicago, Illinois. Per year* $3.00.

Wilson's Photographic Magazine. [*Phot. Mag.*] *Monthly.*
853 *Broadway, New York City. Per year* $3.00.

ORGANIZATION AND ADMINISTRATION.

Our state of defense, U. S.—**Pub. Opin.**, March 3.

The American naval officer of the future (fighting engineers).—**Cas. Mag.**, March.

The strength of the English army.—**Wochenblatt**, March 16.

The English army and navy.—**R. Maritt.**, March; **Int. Revue**, February.

The Federal defense of Australia.—**Jour. R. U. S. I.**, February.

Army reorganization: with especial reference to the infantry of the line and militia.—**Jour. R. U. S. I.**, March.

The fortification of our dockyards.—**Jour. R. U. S. I.**, February.

The French army (practice camps, the 4th battalions, increase of the army of the I. line, etc.).—**A. S. M. Zeit.**, February 26.

The defense of our coasts, France.—**Yacht**, March 5.

The defense of coasts and the food supply of the intrenched camp at Paris. —**Marine F.**, February 15.

The German army in 1897.—**A. S. M. Zeit.**, March 12.

Saxon army list for 1898.—**Wochenblatt**, February 12.

The naval question in Germany.—**Jahrbuecher**, February.

Budget of the German navy for 1898.—**Seewesens**, March.

The Austro-Hungarian army and its last year's maneuvers at Totis.—**Monatschr**, February.

Italian army matters.—**A. S M. Zeit.**, February 26.

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History of army reorganization in Italy, 1896-97.—**Int. Revue**, March.

The defensive strength of Russia.—**Jour. R. U. S. I.**, March.

The recently made changes in the Russian army.—**Int. Revue, March.**

The present organization of the Cossacks.—**Etranger,** February.

The regulation of the Engineer Corps in the Russian army.—**R. Artig.,** January.

The military system of Russia, what it is and what it ought to be.—**Heeres-Zeit.,** February 9, 12, 23; **A. M. Zeit.,** February 17, 21.

Russian sea strength, 1898.—**Int. Revue,** March.

The armed strength of the Balkan states.—**Heeres-Zeit.,** March 9.

The Chinese navy.—**Marine F.,** April 15.

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A scheme for the organization of ammunition columns.—**Jour. U. S. I., India,** January.

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Considerations on the rôle of infantry supports to protect artillery.—**R. Artillerie,** February.

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Attack by cavalry, during a battle, on the transport and supply of an army corps.—**Cercle,** February 12, 26, March 5.

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A chapter of naval strategy.—**R. G. de Marina,** February, March.

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Military interests of the maritime powers in the Orient.—**Marine F.**, April 15.

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A new science of war.—**Jahrbuecher**, February.

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The great siege of Malta, 1865.—**Jour. R. U. S. I.**, February.

1848-49.—**Wochenblatt**, March 16.

The 12th of January, 1848 (revolution of Palermo).—**R. Maritt.**, February.

Operations around Venice in 1809.—**R. M. Suisse**, March.

The story of Corunna.—**Jour. U. S. I., India**, January.

The Civil War in the United States: Shiloh.—**Jour. R. U. S. I.**, January.

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The battle of the Yalu.—**R. M. Brazil**, October-December.

A review of the events of the war in Thessaly.—**Wochenblatt**, January 5, February 9, 12, 23.

The Turko-Grecian war.—**Etranger**, December, January, February; **Monatschr**, January, February.

Progress in the Soudan.—**Int. Revue**, March.

History of the infantry in France.—**R. Infanterie**, February, March.

History of the Italian navy.—**R. Maritt.**, March.

Our relations with Spain. U. S.—**Pub. Opin.**, March 17.

England and Germany from a maritime point of view.—**Int. Revue**, February.

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Infantry drill regulations, 1896, Dutch army.—**M. Gids.**, 2, 1898.

The drills of the English volunteers at Aldershot.—**Wochenblatt**, February 23.

Drill regulations of the German cavalry, September, 1895.—**Monatschr**, January.

Extracts from the new drill regulations of the Russian cavalry.—**Mil. Information Div.**, XVI, part 3.

The new regulations for the German field artillery.—**Jahrbuecher**, February.

Practice march for testing the 7.5 cm. rapid-fire mountain material.—**Cientifico M.**, February 1, 15.

Distance ride of the riding school for instruction of infantry officers, Switzerland.—**Monatschr**, February.

Practical instruction in battle exercises for infantry troops.—**R. Infanterie**, March.

Training of the infantry recruits in the German army.—**A. and N. Reg.**, March 12.

The marching of infantry.—**U. S. Gaz.**, March 19.

Route marching.—**A. and N. Gaz.**, March 19.

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The latest developments in the military applications of the bicycle and balloons.—**Umschau**, February 12.

The importance of ballooning in wars of the future.—**Heeres-Zeit.**, February 26, March 2.

On color photography.—**Photo. Times**, March.

Color processes.—**Photo. Jour.**, February.

A new system of flash-light photography.—**Photo. Times**, March.

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The new carbine and new target practice, U. S.—**Jour. M. S. I.**, March.

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Modern fire-arms and musketry.—**Heeres-Zeit.**, February 9.

The Kynoch cartridge factory.—**Arms and Expl.**, March; **Eng'ing.**, March 4.

The employment of aluminum in the French army.—**Wochenblatt**, January 5.

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The eastern frontier of France.—**Int. Revue**, February.

French colonial possessions in Africa.—**Int. Revue**, February.

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Military study of Menorca.—**M. de Art.**, December, January.

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War observatories constructed of bridge materials.—**R. Artig.**, January.

Rapid bridge construction in America. **R. Artig.**, January.

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Spanish destroyers and torpedo boats destined for Cuba.—**Scien. Amer.**, March 19.

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British and foreign types of battleships.—**Eng.**, March 18.

Gun and steam trials of H. M. S. *Illustrious*.—**Eng'ing.**, March 18.

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Ship building and marine engineering on the Thames in the Victorian era. —**Eng.**, February 11, March 18.

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The automatic closing of holes made by projectiles.—**Yacht**, March 12.

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The construction of the Lorain dry dock and shipyard of the Cleveland Shipbuilding Co.—**Proceedings A. S. Civil Eng'rs.**, March.

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The interpretation of sanitary water analyses.—**Eng'ing. Mag.**, April.

Effects of the penetration of small caliber bullets.—**Cientifico M.**, February 1.

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THE REDUCTION OF IMPEDIMENTA OF TROOPS IN CAMPAIGN.

The incumbrances of an army that hinder its mobility or impair its efficiency are called the impedimenta.*

The impedimenta may be divided into two classes:

1. That carried by the individual soldier or officer.
2. That transported by draft animals or carriers.

It is convenient to discuss the question by making inquiries into the reduction of the soldier's equipment, and the officer's, and then to investigate the general question of transportation.

I. The soldier's equipment.

Military authorities of all countries have, during the last score of years, endeavored to make the soldier independent, for a season, of the train. This independence has been a strong factor in all successful wars, and the teaching is in the right direction provided the burden is not so great as to encroach upon the soldier's marching power or fighting efficiency.

To us this question is most important. We may expect in our next extensive war a greater development of armies than in the last. The regular force is supplemented or swelled by state troops and volunteers. For untried troops, *marching* is a serious difficulty, especially at the beginning of campaigns and "falling out", is an infectious failing often reaching a high percent. Moreover, though railroads *will* confine military operations to well defined lines, we may also expect to make incursions, reconnaissances, demonstrations, and tactically employ large units† that will require an independence of the train. Finally the sol-

*Impedimenta is a general term used by some writers to mean the weight carried by the men; by others as synonymous with equipment generally; by some to mean baggage; by others the general transport including vehicles. It has also been defined to include all the material of any army not essential to the battle and to the excess of weight of such material or any material of any kind

† Sherman's Atlanta campaign is an example of what may, probably will, happen again—and possibly another Vicksburg like campaign.

dier's fighting efficiency, (due much to proper peace training) must not be impaired by an over weighted, ill-adapted or insufficient equipment.

Let us examine the weight, then the adaptation and lastly the sufficiency of our equipment.

a. The weight of the soldier's equipment.

The scope of the subject includes what the soldier *wears* and what he *carries*.

First. What the soldier wears.

Clothing. Suggestions are made as to changes in weight, color and style, etc, the soldiers health being the first consideration.*

1. Texture and material. Cloth woven with moderate looseness makes a poor conductor of heat, preventing the escape of the heat of the body as well as the admission of external heat.

Some articles, as will be seen, are too heavy, from not taking advantage of this law. The *materials* for garments depend on the climate. One cannot expect to campaign on the St. Lawrence with the same clothes he wears on the Rio Grande. Woolen, and cotton and woolen of the present weight of uniform will answer except in the extremes. Light corderoy, an excellent hunter's material, would answer well. The *blue* shirt is a good one. It is pure wool.† Lighter, white underclothing of material somewhat on the Jaeger system has been suggested. The Germans find that though such undergarments fit closely there is no discomfort and that colds are less liable to be taken.

2. Color. 1st: By the laws of heat and light, the ability of the various colors to protect from heat are in the order of white red, orange, yellow, green, blue, violet and black. Gray comes in anywhere between the two extremes depending on the amount of white and black it contains; 2nd: The absorption of the odors of the body depend, curiously, somewhat on the color of the cloth, and in the order, black, blue, red, green, yellow, white. 3rd: The distinctness of objects depends on the contrast of their color to that of the background, and also on their ability to reflect light. These considerations suggest neutral or dust colored grey for campaign uniforms. Objection—patriotic allegiance to army blue.

3. Make of the clothing. *Blouse*—to be made like a sportsman's jacket—loose fitting, turned over collar; four pockets (two for cartridges and two for personal effects). Dispense with the *collar*—use a handkerchief, if necessary, about the neck. It is

* Read Wood, Hull, and Woodruff on military clothing.

† It has the "shrinking liability" when laundried—an objection not insurmountable as soldiers soon learn proper washing methods

more comfortable and more useful. *Trousers*—to be made loose at the waist and knee, cut to come down to above the ankle and to fit the lower leg close (not uncomfortably so) to facilitate tucking inside of leggins or boots.

Head gear. For something that is useful in bivouac and that will protect the wearer from the heat of the sun or from rain, there is perhaps no head cover that is superior to our present campaign hat.

Foot-gear.* Next to the rifle and ammunition, the most important article of equipment is the foot-gear. A comparison of the weights of the horses' shoes, infantry man's shoes, and cavalry man's boots give respectively 48 ounces, 40 to 44 ounces and 64 ounces. The power of the man to the horse is as one to five, but the two feet of the former are nearly as heavily shod as the four feet of the latter. Lighter† shoes can be made by using thick, stiff soles and light uppers—Shoes should be made so that the wearer may step ankle deep in water without leakage. The majority of military opinions consulted favors the adoption of leggins for all troops. Boots are heavier and stiffer in action. They impede evaporation and the feet remain wet after exertion. (To promote an elastic tread the Germans use rubber heels on their boots.) They have decreased the weight of the boot by using lighter uppers.

Stockings. This much neglected article of equipment produces more ills to the foot, corns, ingrowing nails, chafings, blisters, etc., than badly fitted shoes. The fault common to all is narrowing at the toe. Stockings, like shoes, should be *fitted* to the weighted foot. They should be seamless and soft-woven. Garters should not be issued to men. Among the Germans the square cloth has given great satisfaction.

Second. What the soldier carries.

The rifle and bayonet. We have the following comparison with the old Springfield.

Magazine rifle	9 355 lbs.	Springfield rifle . . .	9.30
Bayonet complete . .	.969 lbs.	Bayonet assembled .	.75
Total weight . .	10.351	Total weight . .	10.05

Considering the weights of scabbards equal, the new gun adds $\frac{3}{10}$ pounds to the soldiers' burden. By attaching the bayonet permanently to the gun, reducing its length and weight this additional weight can be more than disposed of. The chief effect

*Aluminum soles and nails are advocated—Liability to slipping and cost are the chief objections

†Read Lieut. Phister's able paper on the infantryman's footwear. J. U. S. I.

that magazine guns have produced is, to have about doubled the supply of ammunition formerly carried by the individual soldier. Thus Austria 100; Italy 96; France 120; Russia 84; Germany 120; England 80; United States 100. 100 cartridges seem to be a necessary and also an adequate allowance. It is an average beyond which there is little gain.

The overcoat.* This is the heaviest article of clothing—five pounds, 12 ounces. A light coat and two jerseys or sweaters will give greater warmth, with a reduction in weight of nearly three pounds. The Germans believe that the lining of the great coat is a superfluous weight. Twenty Austrian tent-coats have been imported for trial.† This new devise has met with considerable success in the Austrian army. It is an overcoat that can be transformed into a V-shaped tent; thus combining the benefits of the shelter tent and great coat. *Spread out*, it is diamond shaped, one end of which forms a hood for use in cold or stormy weather. *Folded*, it makes a sack coat that falls below the knee.

Several spread out and laced together afford sufficient shelter for a squad. One will accommodate a single soldier, the gun and bayonet answering for a pole. If they are capable of service they will prove a valuable adjunct to the soldier's equipment, increasing his comfort and convenience. They effect a reduction of nearly four pounds in weight. Why should not the overcoat and shelter tent be combined?

The blankets. Woolen blankets are the best thing for field bedding. The present one is too closely woven and too heavy for its thickness. A lighter and cheaper one of pure wool more loosely wowen will give equal warmth. The rubber blanket may be somewhat reduced in size, but this change would hardly effect an appreciable reduction in weight.

The canteen and mess-kit (cup, knife, fork, spoon and cooking device) may be reduced in size and should be made of aluminum. Total reduction two-thirds of their original weights. We may consider the most important of these articles (now under trial).‡

1. Canteen (aluminum) or water bottle, the German pattern without joint or seam.

2. The aluminum meat ration can.

3. The aluminum cup (quart).

The ration.§ This item permits the independence of the sol-

*Read Johnson and Brown on the field equipment for officers.

†The report from Ft. Myer is adverse to their adoption. Two other reports are to be heard from. Columbus and Ft. Sheridan.

‡Read Brown on the equipment of the European soldier for various comparisons.

§The Army Regulations for composition of the ration and further reference under Beef Herds.

dier; or as Maurice says in reference to preserved meats and vegetables (the future ration, perhaps*), "one of the modern conditions that effect strategy."

The haversack and rations weigh 12 pounds, 8 ounces. Compressed foods† will, in addition to decreasing this weight, have the advantages of compactness and durability.‡

The adaptation of the soldier's equipment.

This is the most important question affecting the soldier's equipment and it is the main consideration of most European writings on the subject. The manner in which the soldier carries his baggage more vitally affects his marching endurance than pounds of extra weight.

A properly adapted system of equipment must fulfill the following *conditions*, viz:

1. A balanced distribution of the weight carried.

2. Respiration must not be impeded and a free access of air must be given to the back and chest.

3. Facility in putting it on or removing it; and it must also satisfy the *requisities* of

a. Adequate capacity for ammunition.

b. Compactness and durability.

c. Ease of exchanging articles.

Few systems fail to provide for the requisites but none satisfactorily meet the conditions. There are two general systems, viz: the *pack* and the *roll*. The *pack* violates the *first* condition, from its position‡ on the soldier. In some types ammunition is used to aid in counterpoisening. The second condition is fulfilled by the introduction, in some types, (Merriam for instance) of a frame and belt and a skillful piacing of the straps. The third condition is, usually, easily accomplished. The *roll* has points of support from the shoulder to the hip, over the chest and across the back. It secures, in its old form a counterpoised distribution from front to rear but an uneven distribution of the weight between the shoulders; violates the second condition and satisfies the third. A new type of the roll (Lt. Dodge's improvement) fulfills the first condition completely by passing over the soldier's right shoulder a strap, the ends of which pass under the roll, and to which ends the haversack and canteen are attached. At the two points where the roll and strap cross are strings to tie them together. Thus the weight is *balanced* and evenly distrib-

*The victims of our experiments have little faith in this modern innovation.

†Read Sharpe's excellent paper on the supply of armies in the field during the Civil War, J. U. S. I.

‡Carrying the pack low down over the small of the back is objectionable. A cold is invariably produced on removal.

uted. The second condition is met by the introduction, under the roll, of a light, elastic steel spring having points of contact only at the shoulder and hip. The third condition is also satisfied. This type merits *extensive* trial; especially in field exercises. The *pack* generelly meets the requisites for compactness and ease of exchanging articles better than the roll.

Let us examine our own equipment more closely. Though the roll in its old form fails as above noted and is bulky also, it has proved more satisfactory as a whole on marches than the pack. The present device of the latter has a series of ingenious straps across the chest in the exact directions to impede respiration, and straps over the shoulders that likewise hinder the action of the breathing muscles. By actual trial after twenty minutes march with our troops fully equipped with this pack, etc., the pulse rates had risen to an average of 125 and in some cases to 140—figures out of all proportion to the mildness of the exercise and due mostly to make of clothing, disposition of the accouterment and want of practice marches. Frequency of respiration was milarly increased. What would be the result of much marching or campaigning under such conditions?*

c. The sufficiency of our equipment.

The belt carries the ammunition to the field, but it will be difficult to fill it on the firing line in action. Picture a soldier's attitude under fire trying it. To supply extra filled belts in action is for a like reason objectionable, and in addition these belts would add to the weight of the transport and take up much of its space. What the soldier wants is a *pouch* or *bag* suspended from his waist into which he can thrust his supply.

Modern war requires the *intrenching tool* to be a permanent article of equipment.

Medical statistics† show an astonishing number of disabilities resulting from diarrhœa and dysentery. In their mild forms the troops are temporarily unfit for the march of battle. In their acute stages the victims require transportation and hospital attendance. They are the worst of the diseases which afflict armies. The cholera-belt will not give complete immunity from their effect but it will do more than anything else to aid in maintaining

*The Duke of Connaught in his report of the maneuvers of August and September, 180[illegible], in reference to the excessive failings in some battalions (especially foot-sore men) gives the want of practice marches the boot and the equipment as chiefly to blame for the result. "I doubt whether the spirit of my orders (in regard to practice marching) was fully appreciated. I shall continue my efforts to make the soldier accustomed to his equipment." Of the defects of the equipment he gives: 1st. An unbalanced, complicated, uncomfortable pack not readily put on or taken off; 2nd. Too many straps; 3rd. Carries little in proportion to its weight.

†See Medical Report for fiscal year ending June [illegible]th, 1865. Read Slaker's essay Class of 92, Fort Monroe, Va, Artillery School: The equipment analytically considered.

the soldier's health and in preventing a serious encumbrance to the army, i. e., sick men.

* * * * * * * *

We have the following weights of the articles of the soldier's equipment and changes proposed:

THE PRESENT EQUIPMENT.		CHANGE.	
Knapsack	1℔ 14 oz	Knapsack	1℔ 14 oz
One shirt	15½oz	One shirt	15½oz
One pair drawers .	12½oz	Drawers	10 oz
One pair socks . .	4½oz	Socks	4½oz
One pair shoes . .	2℔ 11 oz	Shoes	2℔
One pair trousers .	1℔ 14½oz	Trousers	1℔ 8 oz
Sundries	8 oz	Sundries	8 oz
	9℔s		
Overcoat	5℔ 12 oz	Austrian tent-coat	2℔
Blanket	5℔	Blanket (lighter)	4℔ 6 oz
Rubber blanket . .	2℔ 14 oz	Rubber blanket . .	2℔ 6 oz
Shelter tent . . .	2℔ 6 oz	Two sweaters . . .	(?)
Haversack & rations	25℔		
Canteen and water .	2℔	Haversack & rations	12℔ 8 oz
		Canteen (aluminum) and water	2℔ 4 oz
Ammunition & gun	14℔	Ammunition & gun	14℔
		Intrenching tool . .	(?)
	55℔(near)		
Clothing worn . . .	10℔		
	65℔	Clothing worn . . .	9 ℔

For our service the roll, having stood the test of war, together with the Dodge modification would be the most suitable* compaign system of equipment. Modifications, together with the weights of the sweaters and intrenching tool to be determined, would make a total weight of about 50 to 53 pounds. There will result, after giving a fair weight to the sweaters and intrenching tool, a total reduction in our equipment of ten pounds.

Can our troops *campaign* with the present wardrobe or one as above reduced. The supposition that they can is chiefly based on the capabilities of European continental soldiers.† The latter

*The systems of equipments of our States vary. Generally they are the same as those used by the Regular Army. However some of the States have knapsacks of old pattern. New York and New ersey have adopted the Merriam pack, Pennsylvania has supplied her guard with the modified Baxter knapsacks In most ot the states the men are supplied with bayonet scabbards, waist belts and McKeever cartridge boxes. Great diversity obtains in the various states not only as to knapsacks but also as to canteens, meat ration cans, knives, forks, spoons, tin cups, cartridge belts, clothing bags, etc., much variety as to condition and completeness is very noticeable. The same is true as to articles issued to cavalry and artillery. It would appear wise to settle upon a suitable infantry pack—one that can be unhesitatingly recommended and issued to the States. The greatest help the Government can give them is to complete their equipments on a campaign footing, and to issue to all State troops the SAME system of equipment.

†French troops carry from 61.7 ℔s to 63.8 ℔s ; German troops 65 to 67.6 ℔s. (to be reduced) Austrian, 50.9 ℔s, (by the regulations of 1889); English 57.7 to 62.4 ℔s; Belgian 70.33 ℔s.; Holland troops, 65 ℔s; Russian, 63.6 ℔s.

are habituated to an inseparable companionship with equipment and rifle; and their campaigning fully equipped is made more practicable, by a favorable terrain. What would be the effect upon their endurance in maneuvering through our wildernesses and swamps—and over the rough ground of our country? Of the elements of preparation for war—to march, to bivouac, and to use a weapon effectively—the last is the only of which we, as a people, can boast of superior individual proficiency. Admitting a want of training in the first element (the second being more easily learned) is it wise to increase the difficulty by requiring the soldier to do the work of a pack mule? The experience of our war does not justify the present burden.*

In our campaigns, the terrain, as a rule, required the minimum of equipment.* For general service the following will suffice:

Extra shirt, stockings and shoes, rubber blanket, two sweaters and shelter-tent—all carried in a roll; haversack and rations, canteen (aluminum) and water; intrenching tool and gun and ammunition. Dr. Brock recommends a pipe and tobacco be used.

The total weight of the equipment thus reduced, will be about forty pounds, and this can be further reduced on the eve of battle to the following:

One rubber blanket, two sweaters, haversack and rations, canteen and water; intrenching tool and gun and ammunition.

If the present equipment be insisted upon, a rational means of obtaining the soldier's maximum efficiency, would be to transport that portion of his equipment that he does not absolutely need for general srrvice as above noted. This can be done by pack mules,† allowing six or eight per one hundred men. Otherwise the soldier will solve the question for himself as he did in the last war.

II. The officer's campaign equipment.

The marching endurance of the officer should exceed that of the soldier. Does he require any elaboration of the soldier's equipment to keep him in ihe necessary health? In the affirm-

*"Our troops are undoubtedly loaded down on marches—too heavy even for the road, not to speak of the battle. I have witnessed great loss of knapsacks and articles of clothing on routes taken by our troops at the commencement of campaigns. In my report of the Chancellorsville campaign I showed you that the loss of the knapsacks of those actually engaged was at least 25%. I am in favor of putting the lightest possible weight on the soldier, consistant with his wants and character of the service. I do not think the knapsack should be dispensed with altogether, for it should ordinarily form part of the equipment, but on short campaigns and on the eve of battle, and when near supply trains a blanket rolled up and swung over the shoulder and looped up under the arm is sufficient without knapsack or overcoat. The soldier can carry three days cooked food in his haversack. If necessary he can carry two or three days bread and underclothes in his blanket. Our men are generally overloaded, fed and clad, which detracts from their marching capacity and induces straggling."—Gen. Ingalls report dated August 28th, 1854.

†Towards the close of the the war there was allowed per 1,000 men, twenty-two wagons and 239 pack mules.

ative some writers argue that his mental and physical capabilities demand increased comfort and greater precaution against sickness; in the negative others contend that the soldier's equipment contains every article necessary for the comfort and convenience of a campaigner. It would be well to settle upon a suitable Officer's Campaign Outfit. A judicious paring off of unnecessary articles carried for officers became necessary during the course of our war.* It is believed that the field allowance of 150 pounds is far too great for campaign purposes. The British allow but 80 pounds.

Let us examine the question as to baggage, then as to personal equipment:

a. Baggage.* Adequate baggage would include, a tent-coat (or shelter tent) and blanket.† Extra blouse (1), trousers (1), pair shoes (1), shirt (1), pair socks (1), change of underclothes—Rubber blanket—Light overcoat and two sweaters. All extra baggage and chairs, stools, tables, carpets, rugs, water coolers, extra clothing, etc., should be rigidly excluded.‡ The *mess-kit* articles of moderate number should be made of aluminum. A canvass cover over a wooden frame or a wicker frame will answer to transport the kit. Better still, let officers mess the same as the men. For the transportation of the officer's baggage there were used during the war, pack mules and servants—the latter being convenient and satisfactory.

b. The officer's personal equipment. This the officer carries himself and it should contain such articles as he must use to perform the various duties that may be required of him. For general service these are:

A pad and pencil (or fountain pen) for notes and orders.

The cavalry sketching case, containing all the articles used in reconnaissance.

A rangefinder, whistle and watch.

An aluminum field-glass and an aluminum canteen or water bottle.

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*See G. O. No. 130, A. G. O. September 14th, 1862; G. O. No. 160, A. G. O. October 18th, 1862; G. O. No. 274, A. G. O. August 7th 1863, and Special Orders No. 44, Headquarters armies United States, City Point, Va., June 28th, 1864. In the exigences of service the above baggage should be reduced to this: Officers baggage will be limited to blankets, one small valice or carpet bag and a moderate mess-kit.

†Many reccommend a sleeping bag of light weight canvass lined with sheep-skin, 7′x 3′, for bedding. In the space inside the bag and above the slit can be placed the underclothing towel, socks, shoes etc., to be used as a head rest, and on the other, soap and various other articles. Its arrangement and compactness, and its excellence as a bivouac outfit, recommend it as a very useful adjunct of the officer's equipment. Read Lieutenant Johnson's article on the Officers Field Equipment, J. M. S. I.

‡The greatest delinquents have been the field and general officers. No better motto could be given them than the following assertion of an English general officer's: "In active campaigns I take three stockings with me. Two I wear. The third is washed and dried and exchanged with the one longest on duty. Though improbable the remark illustrates the point.

For any special work requiring a more elaborate or different equipment the officer should be furnished with the extras. The above can be very conveniently carried— the pad and pencil (or pen), whistle and watch in the pockets—the sketching outfit in a leather case swung over the shoulder—likewise the remaining articles.

In the personal equipment we will speak of the arms the officer carries. By regulations, based on conservative notions of tradition, this is a sword which, from any reasonable standpoint, should be, in campaign, replaced by an excellent revolver. The latter is compact, weighs no more than the sword. On the other hand the sword is a positive hindrance in action. It is objectionable from its weight, shape and brightness. It has outlived its usefulness as a weapon of war. The *clothing* worn by officers while being serviceable and healthy, should be made of the same color as that worn by the men. *Blouse*, to be made loose, with no braid, a rolling collar, and four pockets. *Trousers* cut for comfortable wear. Leggins and shoes for all officers. Campaign hat. Gloves of dull grey. Woolen shirts and Jaeger underclothes. Hand made shoes fitted to the weighted foot and stockings of wool soft woven and seamless.

III. Transportation.*

Under this head let us consider the various questions that affect the amount of useless impedimenta.

Tenting and bivouacing. Napoleon overcame Europe with the bivouac. (Emerson.)

"Tents are not healthy. It is better for the soldier to bivouac because he sleeps with his feet to the fire whose neighborhood quickly dries the ground on which he lies. Some planks or a a little straw will shelter him from the wind. Nevertheless a tent is necessary for superior officers who have need to write, and to consult a map."—Napoleon.

Bivouacing is miserable work in wet and unhealthy climates, but in dry, healthy ones it is without question superior to tenting—superior from the fresh invigorating air that the stuffy tent does not afford—superior from the military considerations of quickness to take up the march or meet attacks, and lightness of the burden carried. It is easily learned from nature. For a man lying prone on the earth, a screen 18 inches high protects him from the strength of the storm. Experienced travelers say that on the barest plain, such shelter can be readily improvised. Frequently nature has already provided it and oftener it is un-

*Read Sharp's excellent paper on the supply of armies during the war, J. M. S. I.

desired. This screening *wall* is a sufficient protection from wind and driving rain, but against dew, vertical rain, or from cold we need a *roof*, whether it be a tent, sleeping bag, tree* or waterproof cover. Much thought has been devoted to devising an efficient bivouac cover, the most successful device appears to be the tent-coat. Many are reluctant to part with the shelter tent or tent d'abri. * * * The most successful leaders have resorted to the bivouac; particularly in ancient and medevial wars—notably the crusaders—and during the French Revolution, Napoleonic Wars, The American Revolution and Civil War. (See G. Os. No. 130, A. G. O., September 14th, 1862, etc., No. 160, Oct. 18th, 1863, etc.) "Tents should be omitted altogether save one to a regiment for one officer and a few for the division hospital. Officers should be content with a tent fly, improvising poles and shelter out of bushes. The tent d'abri carried by the soldier himself is all sufficient. Officers should never seek for houses but share the condition of their men." (Sherman).† A. J. Smith made his campaign in the southwest without tentage. In fact he had scarcely any incumbrance worthy of the name of impedimenta.

"For seventeen days, says Grant, I lived on a tooth pick and bivouaced under a blanket. (During the Vicksburg campaign.) My example had a good effect on the men." The experience of the Confederates in resorting to bivouac needs no comment.

On going to war one may as well determine to rough it.

Therefore all tentage should be abolished, except what little is required for office work and hospital service. Bivouacing requires that men be seasoned. The process is from the home, through recruiting and training in camp, to the bivouac.

2. Necessaries and luxuries.

At the outset of the Rebellion the amount of baggage considered necessary and allowed to armies in the field was excessive. It was not uncommon that regiments had provided themselves not only with the essentials for *campaigning* but also with all the comforts for *outing*, i. e. wines, liquors, dainties, cots, trunks, boxes, etc.‡

"In one case a single regiment had as much baggage and required as much transportation as an army corps." (McClellan).

*Novices select the tree as a choice camping place—spreading above a good roof but without protection below. In driving winds trees are positive nuisances. The real shelter is a dense low screen, knee high. A fence corner is a luxury.

†The American Revolutionists filled with constant self denials on the part of all officers. It is indeed a study on reduced impedimenta from which much profit can be obtained.

‡Really due in great measure to the system of recruitment then in vogue—wherein the state forces with their leaders came to the front in much the same manner as did the lords and their followers in feudal warfare, i. e. with all the trunks they could drag with them.

Of the overloaded transport, Halleck in his report of Nov. 25th, 1862, says: If it be true that the success of an army depends upon its arms and legs. ours has shown itself deficient in the latter of these essèntial requisites. This defect has been attributed to our enormous baggage and supply trains. * * There is no doubt that the baggage trains of our armies are excessively large. Every effort has been made * * * to reduce them but it is no easy matter. Once accustomed to a certain amount of transportation, an army is unwilling to do without the luxuries which it supplies in the field." Such serious mistakes must be prevented at the outset by proper recruiting and organizing depots.*

3. The officer's ration, etc. It became necessary to abolish this distinct issue during the war. There is no good reason for its being reintroduced. "It will be well for the future officer," says Wolseley, "if he can make up his mind to live like a soldier." Whether or not we will have "the short operations of future wars"—this reduction will materially aid in simplifying the rations issued to troops and officers. The extra baggage and furniture carried for officers have already been mentioned.

4. The stores captured. The subject admits of long discussion. The imprudence has often been committed of overloading the trains with totally unnecessary booty, stores, etc., captured in action—and in many instances such overloading was the cause of subsequent disaster. The establishment of depots on the line of advance for these stores or their destruction on retreat will aid in their proper disposition.

* * * * * *

We have also considerations that bear on the reduction of the necessary impedimenta and its management.

1. The utilization of local resources. Ultimate reliance must always be on the base and train; but remarkable campaigns away from the base of supplies have been conducted by taking advantage of the country resources—notably Grant's Vicksburg campaign, Sherman's Atlanta campaign and March to the Sea. Contribution, Requisition and Foraging are the means employed. * * * From the supplies procured, men can husband their

*In mortification with the inability of the Frence troops to equal their opponents in celerity of maneuver, Darut, in 1787, thus pointedly writes: "Success shall not be attained until we banish all useless embaras (impedimenta), and regulate before war, the form materials, weight and number of things each unit is permitted to have. The [illegible] perfection in this branch seems chimerical. * * It would be necessary that laws concerning (army women and) servants were made and enforced; that the law concerning the number of horses allowed could not be transgressed by any one whomsoever, even by the general of the army * * * no vehicles for luxuries permitted * * * That all materials of war, such as harness wagons, canteens etc., be of the same weight and nature made from the same models the strongest, lightest simplest and least expensive." The remarks are to the point today.

hard bread and ration for emergencies.* In direct connection with this consideration comes that of

2. Beef herds. Driving cattle on the hoof was done by all the armies. The beef was slaughtered for the evening meal, on halting for bivouac. Almost immediately after the halt, the quivering flesh was over the fire, Thus enroute the troops had a fresh-meat ration and except hard bread the rest of the ration was reduced ane-half. General Orders, at the commencement of the war prescribed that, in ordinary marches when the troops could receive daily issues from the trains they could carry only two day's rations; but in the immediate vicinity of the enemy, and where the exigencies of the service rendered it necessary for the troops to move without baggage or trains, the men were required to carry from eight to twelve days rations which were arranged as follows:

FOR EIGHT DAYS.

5 days beef or mutton to be driven on the hoof or collected in the country passed over	
3 days cooked rations in the haversack	5¾ lbs.
5 days rations of bread and small stores in knapsack	6
A change of clothing in knapsack	2
A blanket	5¼
Total	19

FOR TWELVE DAYS.

9 days ration of meat on the hoof	
3 days cooked rations in the haversack	5¾ lbs
9 days rations of biscuit and small stores in haversack	19½
A change of underclothes in knapsack	2
A Blanket	5¼†
Total	23½

"The difficulty of obtaining proper pasturage, the slow rate of movements which the herd is capable of, and the fact that one or more roads in rear of the army must be given up to the use of the herd, are (now that the method of shipping dressed meats

*General Orders No. 7. Headquarters of the Military Division of the Mississippi, dated April 18th, 1864, provided: "II When troops are ordered to march for action or to be in condition for action all encumbrances must be left in store at the most safe and convenient point. Mounted officers (general, regimental or cavalry) will be expected to carry on their own or led horses, the necessary bedding and changes of clothing, with forage and provisions for themselves for three days—*which must last five days*. Infantry officers and soldiers must carry on their persons or on led horses or mules the same, to which end will be allowed to each company when practicable—one led horse or pack mule. Artillery can carry the same on their cassions, so that all troops must be in readiness for motion without wagons, for a five days operation" Smith's troops in the Southwest were frequently supplied with *two* days rations to last five. That they did not suffer from the stringency is shown by the fact that the health of the men was unusually good.—Grant's order waiting movement south of Vicksburg.

†Note closing remarks on the soldier's equipment (Ante).

by means of the cold storage system is so much in vogue), very potent objections to the practice of furnishing beef supply of an army by means of a cattle herd. But * * * if this method of supply is to be abondoned a large increase will be required in the transportion furnished the various armies." (Sharpe). (Read Kobbé's Notes on Strategy and Logistics).

* * * * * *

3. Means of transportion. Influence of magazine arms on the amount of transportation.

4. Question of management or administration.

* * * * * *

We will meet again with the same difficulties we experienced in the last war and probably they will be in an aggravated form. The abuses to transport are mentioned that attention may be quickly drawn to them and that they may be prevented from happening again. It is impossible to prescribe beforehand a *minimum impedimenta* or allowance of transportion. Impedimenta must adapt itself to the requirements of war. We are prone to take European standards and methods and to slight our own experience; whence a knowledge of the physical character of our country, its resources, and its vast railroad and water routes i. e. *our own capabilities* both during the war and now will do much to promote from the outset an efficient transportation system.

At the outstart of the Civil War we had an excessive transport. Thus Ingalls in his first report, July 1862, shows that the Army of the Potomac had the following transport: 3,100 wagons; 340 ambulances; 17,000 horses, 800 mules to an army of 80,000 men, or *forty* wagons per 1000 men. After the battle of Antietam, the transport consisted of 3,911 wagons; 907 ambulances; 12,483 mules; 8,693 horses not including those with the artillery and cavalry; the army numbered 110,000 men, or 29 wagons per 1000 men. In the Gettysburg campaign the wagons numbered over 4,000. After the retreat of the rebel army from Gettysburg the Army of the Potomac was ordered concentrated at Middletown on the evening of July 7th, and no trains but ammunition trains, medical wagons and ambulances were permitted to accompany the troops. The corps trains of baggage and supply were packed in Middletown valley. Grant crossed the Rapidan with 125,000 men; 4,300 wagons, 835 ambulances; 29,945 cavalry, ambulance and team horses, 4,049 private horses and 22,528 mules; or 34 wagons to every 1,000 men. At Appomattox he had 107.777 horses and 25.790 mules; 2,448 wagons; or 22 wagons and 239 draft animals per 1,000 men.

On July 1st, Sherman's army numbered 100,000 men; 28,300 horses: 32,600 mules; 5180 wagons; 860 ambulances or 60 wagons per 1,000 men. On leaving Atlanta he had 63,680 men; 14,768 horses: 19,410 mules; 2,520 wagons, and 440 ambulances or 40 wagons per 1000 men.

The size of the trains diminished as the armies gained in experience. The reduction of the transport was the subject of General Orders, A. G. O., (No. 130, September 14th, 1862; No. 160, October 18th, 1862; No. 274, August 7th, 1863) and Special Orders from Army Headquarters. Special Order No. 44, Headquarters Armies United States, City Point, Va., June 28th, 1864 gives a *standard* upon which all estimates for armies in the field may be based:

Army Corps Headquarters—four wagons or eight pack mules.
Division Headquarters—three wagons or five pack mules.
Brigade Headquarters—two wagons or five pack mules.

This transport of wagons and animals for all personal baggage, mess chests, cooking utensils, desks paper, etc.

Each regiment of infantry, cavalry or battalion of heavy artillery, *two* wagons; for each battery of artillery *one* wagon. The number of wagons allowed for artillery ammunition depended on the number and character of the guns; for the reserve artillery there was to be 20 rounds of ammunition to each gun; for small arm ammunition there were allowed *three* wagons for every 1000 men of cavalry, infantry and heavy artillery present for duty, for fuses, powder and primers for the reserve ammunition train, *two* wagons. For the general supply train, *seven* wagons to each 1000 men of cavalry, infantry or heavy artillery. for forage, subsistence. etc., which should carry eight days supply; to each cavalry division exclusively for forage, fifty wagons; to each battery for its subsistance and forage, four wagons; each horse battery for the same purpose, four wagons; for every 25 wagons of artillery ammunition train, five wagons additional for the forage of the animals and the subsistence of the men. Ammunition trains were loaded exclusively with ammunition. To each brigade for hospital supplies, three wagons; to each corps headquarters for forage and subsistence, three wagons, each division, two; each brigade. one; and to each brigade one wagon for commissary stores for sale to officers. The limit of organization of the trains was the division. In the Division of the Mississippi no wagon for commissary stores for sale to officers was permitted—the officers being restricted to the same food as the men.

The above is given as a standard of estimate only. It is in most respects a model. The reduction of impedimenta must effect itself during war. The foregoing indications may prevent transport abuse.

[NOTE:—This paper has been prepared from consulting various sources of authority—Brown, Johnson, Phister, Sharpe, Slaker, Woodruff,—General Orders, etc.]

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THE ARTILLERY IN BATTLE.*

A lecture prepared for the Course in Tactics, U. S. Artillery School.

The conduct of the artillery in battle differs somewhat according as it is on the offensive or defensive side, and in the attack whether it is a renconter combat (double offensive) or an attack on a prepared position (simple offensive).

THE ATTACK.

In general, the attack is characterised above all by a tendency to bring the firing continually *nearer* to the enemy; in the renconter combat, or double offensive, the artillery must come *rapidly* into position. in order to get an advantage over the enemy, whereas in the simple offensive the artillery combat must be postponed until a sufficient number of batteries are ready to enter the action at one time.

The enemy's artillery is under all circumstances the first target for the artillery of the attacker. In case the latter cannot produce a decisive effect on the enemy's artillery from its first position it must move up to closer ranges.

As soon as the commander-in-chief has selected the principle point of attack for the infantry, the artillery has to prepare this point for attack by concentrating on it an overwhelming fire, after which only a portion of the artillery is used against that portion of the enemy's artillery which commands the field of advance for the attack.

To prepare for the actual assault of the infantry a rapid and effective fire is necessary. This can take place without change of position only when the conditions necessary for good fire do not imperil our own troops, viz: the ability to distinguish friend from foe, the distribution of the fire, the observation of the shots, etc. When these conditions are no longer fulfilled, the artillery must advance to better positions. Often single batteries will *accompany* the infantry advance for moral effect, taking position and opening fire from time to time to support the advance.

When the two opposing lines of infantry are so close that the continuation of artillery fire on the point of attack is impossible, the fire is directed on the batteries still in action, in order to

* Compiled from *Tactique de combat de l'artillerie*, Com. Cahuzac, and from the works of Meckel Weldstätten, Shaw and Wagner.

prevent their re-appearance, and also on troops in rear of the enemy's line, but it must also be prepared, in case of defeat, to cover the retreat.

In case the attack is successful, the retreated enemy must be demoralized by artillery fire, and the infantry supported in the positions it has taken, therefore the artillery hastens to the new line.

The actual pursuit is the duty of the *entire* artillery, taking up positons for effective flank fire, especially on the subdivisions still in order.

The artillery attached to cavalry brigades or divisions is also usually handled as a single body, because many lines of fire would interfere with the movements of the cavalry, and each separate group would necessitate increased support for the artillery.

The artillery attack precedes the cavalry attack, but the position taken must not be so far to the front that the enemy can reach it before our own troops. Positions to one side are better than those directly to the front. When an attack is threatened the artillery hastens to take position quickly where it can command the field. Changes of position are usually out of the question, but the few shots that the artillery can get in before the charge may be decisive of the result.

As soon as the enemy's cavalry comes within effective range, the artillery unites all its action on it, regardless of the enemy's artillery; but if our own cavalry is not ready to attack, the artillery fires on the enemy's batteries to draw their fire on itself. At the charge the artillery again turns on the enemy's batteries, or on any reinforcements that the enemy may bring up.

Even in a battle of all arms the artillery attached to the cavalry remains with it.

The sequence of events in the attack may be described as follows:

The Double Offensive.—The first act will be marked at first by combats of cavalry against cavalry, then by the attack and defense of positions by cavalry supported by infantry. The rôle, during this period, of the artillery attached to the cavalry may be summed up as follows:

1. The horse artillery must remain with the main body of the division and conform to all its movements. As soon as the vicinity of the enemy compels the division to march in a concentrated formation, the artillery goes about 400 yards to the front and to one flank, and as soon as the division deploys for combat it takes a corresponding position with reference to the first line.

2. The order to come into action should not be given to the artillery until the order to attack is given to the division. The commandant of the artillery marches with the commander of the division until the order to come into action is given him, when he takes personal command of the batteries. He selects for the artillery, within a radius of 650 yards, a position on the flank whence a good view of the field of the enemy's approach can be obtained, takes the battery at a rapid gait and immediately opens fire.

3. Position is not changed during the combat, except when absolutely necessary. and then it is done by echelons.

4. In case of success, the artillery assists in the pursuit by increasing its range rather than by change of position, and endeavors to prevent the enemy's artillery from carrying along his limbers.

5. In case of a reverse, the artillery continues to fire with increased rapidity on the enemy's squadrons. The addition of a battery of machine guns to the two horse artillery batteries would be an excellent means of supporting the cavalry, especially by its fire on the enemy's cavalry or his infantry supports, and may possibly enable us to dispense with the infantry support.

The second act of the battle now opens. As soon as the artillery of the advance is forced to deploy completely, the commander of that advance guard brings his artillery into action, the latter taking position about 3200 yards from the crests of the enemy's probable artillery positions, near the road, as rapidly as possible. The objective is the enemy's infantry until his artillery is unmasked, and no great pains are taken to secure cover, but effort is made to get behind a crest or rise, where there is an extended field of fire in front.

When the resistance experienced by the advance guard becomes well marked, the artillery of the main body is called up, and forms on one or both flanks of the advance guard batteries, if possible, at 2700 yards from the enemy; the group of howitzers or mortars is also ordered up, but is held in reserve out of sight and protected from fire.

Great care is taken by these batteries in advancing into the first position, to keep out of sight, and positions *behind* crests and under natural cover are preferred, but no undue attention is paid to cover. because a position behind cover usually implies indirect fire, which may not have the desired effect at once.

One officer for each group of three batteries is sent out in front to reconnoiter the approaches.

In the artillery fight the enemy's artillery is taken under fire group by group, but the fire of a group is concentrated on each of the enemy's batteries in succession. As soon as the superiority of fire on the enemy's artillery begins to tell, the artillery is ordered forward to the decisive distance, about 2100 yards from the enemy's batteries. The change is made by echelons of groups, no attention is paid to cover, and the firing is conducted with the greatest energy.

This introduces the third act of the battle. The corps commander decides upon the decisive point of attack and makes his preparations. He designates the batteries which are to prepare this attack, those which are to watch the enemy's artillery and those which are to accompany the troops in the attack. The artillery commander calls up the group of field howitzers or mortars, and puts them in position, completely masked from the enemy, at about 1900 yards from the target.

This battery is at once prepared for action, its targets being natural points of support, such as a farm or a village presenting obstacles which the field artillery cannot cope with. Indirect fire is of course imposed.

The other batteries assist in preparing the infantry attack, remaining in the position where the artillery duel ended.

The howitzers or mortars, after having destroyed the first objective with shell, fire with shrapnel in front of the advancing troops. The other batteries fire on the approaches to the objective, in front and in rear, those accompanying the troops taking position at about 1600 yards.

As soon as the preparation is judged completed, the batteries accompanying the troops, supported by horse batteries from the cavalry on security and information service, take up a position at 1300 or 1000 yards on the exterior flank, and open a rapid fire. All the batteries which have a view of the objective point increase their fire, and follow the progress of the battle by changing their elevation. The howitzers or mortars alone continue to fire on the objective till the last moment.

If the assault succeeds the batteries attached to the troops move forward as soon as the third line reaches them and come into action in the captured position, firing on the enemy from that point. The other batteries follow the movement and come into the same position. The targets of the artillery are the enemy's infantry, his points of support, and his batteries protecting his retreat.

If the attack is repulsed, the artillery retires in echelons of groups, but only on the receipt of a formal order.

The Simple Offensive.—In the simple offensive the artillery will first have to attack the defender's advanced lines. The principles are the same as in the double offensive, except that the artillery can be bolder on account of the numerical superiority of the attack at this time. The howitzers or mortars will be used against the point of support, either natural or artificial, and will proceed as before described.

For the principal attack more tact and prudence are required, and the batteries must be careful not to expose themselves, or they may be annihilated by batteries in position.

In the occupation of the first duel position the same rule applies, and much use will be made of indirect fire and scouts; from the second duel position to the end the events are exactly as in the double offensive. Convergent fire is the great object sought by the offensive, since the defender's fire is necessarily divergent.

THE DEFENSE.

The defensive action is characterized by the holding of a position, combined with the endeavor to hurl back the attacker.

The first duty is the skilful use of the ground and its preparation for defense (cover for guns, artificial masks, determination of distances to various points, clearing the field, etc.).

Taking a preliminary position behind the prepared line not only obviates early changes of position after the battle opens, but also prevents the enemy from getting a clear insight into the defensive dispositions early in the action. But the artillery of the defense must endeavor to occupy its position before the enemy's is developed, in order to fire on his artillery while deploying.

If the artillery of the defense is unable to enter the lists against the attacker's artillery, it may withdraw from the effective fire of the latter, but it *must* enter the action when the hostile infantry attack begins. In this case hidden batteries, commanding the enemy's principal line of approach are especially important.

As soon as the enemy exposes his masses of the other arms, the artillery takes the latter, especially the infantry, as its target, irrespective of the enemy's guns, and only exceptionally are the latter engaged. In case the enemy is nevertheless successful, the artillery, without regard to its own safety, endeavors by firmly holding out, to gain time for the other troops to retire in good

order. In the retreat itself it delays the pursuit by taking advantageous positions at defiles and on the flanks.

The events in the defensive battle will succeed one another somewhat as follows:

The rôle of the horse artillery attached to the cavalry divisions of the first line is the same as in the offensive. The horse artillery of the cavalry on security and information duty, as well as the field artillery, form with that cavalry and its infantry supports *covering detachments* as in the occupation and defense of advanced posts.

Advanced lines, well fortified and strongly occupied, which are more than 1600 yards from the principal position, must be strenghtened with guns. The proportion of the latter may be considerable on account of the mobility of the arm. It should remain concealed as much as possible, offer no target for the enemy, and act by surprise. Indeed, this is a general rule for the conduct of the artillery, that in the principal position as well as that in the advanced line.

The batteries are prepared for indirect fire, the distances to all points of approach are measured, and if need be epaulments are constructed.

When the advanced line has to be abandoned the batteries retire first, at a rapid gait.

The artillery is posted in groups a little in rear of the principal position, but so that the approaches to the position are well under fire. An army corps has its artillery in three or four groups, one or two at the center and one at each flank. The batteries should be completely masked from view and protected from fire, and these emplacements should be occupied a little before the enemy enters the zone of effective fire, distances having been previously determined, and all preparations for indirect fire having been made.

As soon as the enemy shows his guns the artillery of the defense endeavors to gain the upper hand by an energetic concentric fire on the groups successively entering the line: this is its great opportunity.

If the artillery of the defense is subdued the batteries which have suffered most are retired temporarily and prepared for the close-range duel.

When the preparation for the attack begins the batteries to take part in the close-range defense are designated and must be in position when the attack opens.

The group of howitzers or mortars, held in reserve up to this

time, is posted in rear of and on the flank of the objective point, masked and protected. Its fire is directed on the points of support of the advanced line occupied by the enemy and then on the troops massing for the assault.

As soon as the direction of the attack is evident the batteries designated for the defense occupy their proper emplacements and open rapid fire on the troops. This is the time for the counter-attack. The artillery redoubles its fire and takes for its target the troops against which the counter-attack is directed.

If the attack succeeds the group of howitzers or mortars is sent to the rear to the next position to be held, a part of the corps artillery being sent there after it. The other batteries hold on until they receive orders to retire, which is effected by echelons, each under protection of the batteries still in position.

As soon as the enemy occupies the position the group of howitzers or mortars and the corps artillery batteries with it open a concentric fire on that position to cover the retreat of the other batteries.

NIGHT COMBATS.

In considering night combats it is necessary to distinguish between those that have been preceded by an action during the day, and those that have not.

The artillery of the attack cannot generally be used at night in case no action has taken place during the day, because of the danger of firing on its own troops, moreover, this arm loses all its mobility at night and is obliged to go into battery near the roads, and all secrecy (the essential quality of all night combats) is prevented by the noise of the wheels.

The artillery of the defense, however, can play its part ; it can enfilade a road or bridge and stop the attacker by its canister fire.

In the great battles of the future the part played by the artilleries during the night will be very different to what it has been in the past. The three acts of the battle cannot always be played to the end in the same day, indeed, two or three days will hardly suffice, and both sides will take advantage of the night. The result of the long contest will be that both sides will become thoroughly familiar with the ground. The night enterprises may be decisive and will certainly be very important. They will always be combats of position, the objective being perfectly definite, and appreciated by both sides, generally a farm, a hamlet, or a fortified crest, which have resisted all attack during the day.

The attacker will place a certain number of batteries in position

toward the close of day, behind the zone in which the attacking troops are to advance. Distances will be carefully measured to the objective, and before night-fall the guns are ranged carefully. As soon as the troops begin to move to the attack, the batteries bombard the objective point with a heavy fire, and when the infantry arrives at 500 yards from the objective the artillery fires on the zone in rear to a depth of about 500 yards. In no case will the artillery thus engaged change its position.

The defender uses his fire in a similar way. If he expects an attack on a certain point he posts batteries there a little before dark, and they carefully note the ground over which the attacking troops must pass. When the attack develops they take under fire the ground in front to a depth of 500 to 1000 yards, taking as the inferior limit a line about 500 yards in front of the objective. The batteries do not change position, but reconnoiter the road along which they will have to retire in case the attack succeeds.

The same rules apply to the use of artillery on the outposts.

RAPID-FIRE GUNS.

The introduction of a rapid-fire gun in the field artillery will not alter the principles governing its use in battle.

The power of the defense is increased (as in every case of improvement of the weapon), and attacks not properly prepared will be more severely punished than ever, on the other hand, a superior artillery, properly handled (if the ground is not *entirely* open) will be able to subdue the adversary in a much shorter time, and decide the action.

Caution in approaching and occupying the first positions is more than ever necessary, as well as care to remain outside of the zone of effective fire except when under cover.

Enfilade fire will be much more effective. as well as the fire of batteries commanding the approaches of attacking infantry, but the defender will find it much more difficult to bring into action again batteries which have once been withdrawn.

In cavalry combats the rapid-fire gun will have its greatest advantage.

Rapid-fire guns were used in actual war for the first time at Adua by the Italians.

General Bartieri, in his march on the night of March 1st, 1896, on Adua, had 18000 men and 56 guns, 12 of which were rapid-fire guns. The latter formed two batteries under Captains Aragno and Mangia, both graduates of the artillery and officers

with excellent records, and were assigned to the reserve brigade Ellena.

When the battle on the morning of March 1st took an unfavorable turn at about 8 o'clock, General Baratieri ordered both these batteries and the 3d Askari battalion to support the brigade Arimondi. the left flank of which was being turned. The batteries, after taking their position, found themselves under the fire of skirmishers, concealed in a terrain covered with bushes, at 200—300 m. distance. The ground offered no better position and time was pressing. Heavy masses of Abessynians pressed forward and deployed within good range. But the observation of the shots was difficult, because of the light cloud of smoke, disappearing very quickly. It is proposed to use in projectiles for rapid-fire guns, a special powder giving a heavy cloud of smoke. Fortunately, the ordinary 7 cm. batteries near by determined the range. Rapid-fire at the correct range was opened. In spite of their terrific effect they seemed to make no impression on the Abessynians. Soon it became necessary to economize ammunition, and rapid-fire was used only by special command at particular moments.

Both batteries used smokeless Philit powder, but notwithstanding this the Abessynians could detect the position of the batteries by the flame issuing from the guns, and by the outlines of pieces and cannoneers. The losses in men and animals increased, the Abessynian skirmishers became bolder, and the battery commanders ordered canister fire.

The Italians were being outflanked, the situation was critical, the fire was therefore directed on the closed battalions pressing forward now. The moment for putting in the infantry supports had arrived, but these were soon surrounded by the enemy and decimated. and so the batteries could no longer count on a support. Both captains were mortally wounded, then both senior lieutenants fell.

The 2d battery was ordered to a position in rear, but it was too late. The Abessynians advanced with their horrible cry, beating incessantly their copper drums covered with ox-hide. At this moment Sergeant Pannochia covered one of the guns, which had been removed from its carriage. with his cloak. The only officer left (Lieutenant Scalfaro), seeing that most of the men and animals were killed, decided that it was useless to try to withdraw the battery. In a few moments the Abessynians were in its midst, and the lieutenant ordered the sergeant to leave his post

and save himself, but the sergent remained, holding the gun on his knees, with his arms about it, and was killed there. The lieutenant jumped on a mule and escaped. That evening the 56 guns and the artillery park adorned the front of the imperial headquarters.

This was the unfortunate outcome of the first appearance of the rapid-fire gun in battle.

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NIGHT COMBATS.

Kriegsgeschichtliche Beispiele aus dem deustch-fransöischen Kriege.
Major Kunz.

After Marshal Bazaine had been informed of the capitulation of Sedan, Prince Frederick Charles decided to bombard the French camp around Metz during the night in order to force him to come to terms. The night was selected to avoid unnecessary losses from the heavy guns of the fortifications. To General Steinmetz was committed the duty to take Fort St. Privat at the same time, but that General, for strong reasons, abstained from making the effort.

The following guns were collected for the bombardment:

One 6-pounder battery of the III army corps near Saulny.

Three 6-pounder batteries and one 4-pounder battery of the X army corps in the line St. Remy—Bellevue.

Six 6-pounder batteries of the IX army corps in the line St. Hubert—ruin of Chatel St. Germain, these batteries to fire over the saddle between Forts St. Quentin and Plappeville.

Six 6-pounder batteries of the VII army corps, about 1000 paces in front of Pouilly.

One 6-pounder and one 4-pounder battery of the VIII corps near Tournebride on the right bank and on a line with Vaux.

Ten 12 cm. guns south-west of Rozerieulles on the plateau south-east of the stone quarries of Point du Jour.

The higher artillery officers (the brigade commanders) examined the positions selected as early as the morning of the ninth of September. Each gun was to fire 12 shots, except those of the VIII corps which were to fire 20. To increase the range the the trails of many of the pieces were sunk in the earth, so that elevations up to 20½° could be given. The guns were placed with wide intervals, up to 40 paces, to diminish the effect of the enemy's fire.

The mass of artillery brought into action was quite considerable:

10	rifled	12 cm. guns.
102	rifled	6 pdr. guns.
12	rifled	4 pdr. guns.
Total 124		guns.

On the ninth of September the sun sets here at 6.28. The

firing did not open till 7 p. m., hence after dark, and, as it happened, in a driving rain. Observation of the effects of the firing was entirely out of the question. The ten rifled 12 cm. guns were not placed in battery until 6.15, and the shells were not yet loaded; but in spite of this even this battery was ready to fire at 7.30. The continual hard rain had so softened the ground that the effect of the shell was greatly diminished.

The impression of the shell fire on the inhabitants of Metz was quite remarkable the people streaming out to points of observation, especially along the walls of the esplanade. They did not understand what object the Germans could have in view in this night bombardment. The troops took their positions for defense, and the forts Queleu, Plappeville and St. Quentin opened fire.

Numerous shells from the German artillery struck the workshops of the railroad station at Montigny, and several houses in Montigny were considerably damaged. The villages of Tignomont, Plappeville and Woippy, and the cemetery of Sey were struck; and also the French camp. Shells passed through the tents, even the forts Queleu and St. Quentin received shells, but the material effect was very slight because many shells did not burst. Much slighter were the losses of the French; they amounted to 2 men killed, and 1 officer and 10 men wounded. However, the bombardment had the effect of drawing out the French troops to their defensive position, and causing them to be drenched to the skin.

In less than an hour the German artillery ceased firing, because the circumstances were altogether too unfavorable, and the failure of the attempt was clearly evident. Moreover, the German troops, which had to take their positions prepared for attack, were naturally as wet as the French, and the hygienic condition of the troops was made much worse thereby.

The result of the firing was practically zero; of that there can be no doubt. If we assume that the German artillery actually fired all the shells prescribed, this would make 1584 shells; let us take it at 1500 shells, although Freiherr v. Fircks, Part II, p. 145, of his work on the defense of Metz states that the six batteries of the VII corps alone fired 2500 shells, and we will still have 100 shells for every Frenchman struck!

This must be regarded, without further comment, as a waste of ammunition. However, the weather on the ninth of September was very unfavorable; many may believe that in dry weather the firing would have been more effective. That is very true, but the French would have taken up their defensive positions in any

event, and even in a clear moonlight or starlight night only the first shells could have struck in the French camp. Even if we assume the effect to have been ten times as great, what would have been accomplished? A temporary confusion, some disorder, some discomfort, nothing more.

A bombardment at indeterminate ranges can have no purpose; only *the concentrated action of a strong artillery mass on a limited area* brings about great results. To bring to bear an effective artillery fire on the Army of the Rhine in Metz, which was certainly a good idea, we would require not the 50 rifled 12 cm. guns, which had actually arrived in Novéant in front of Metz on the 31st of August, but 400 heavy siege guns! With this armament something could have been done, and it would have been very hard for the French to withstand the fire of such an artillery mass, which could have been more than doubled by the field artillery in front of Metz, for any length of time. But a bombardment by night, under torrents of rain, could only disturb the French, and in an hour all fears were quited.

The French artillery fire had no effect whatever, not a man or a horse on the German side was even wounded.

THE BATTLE OF ST. PRIVAT LA MONTAGNE ON THE EVENING OF AUGUST 18, 1870.

The sun sets here at 7.18 on August 18th, and the storming of St. Privat la Montagne did not begin till 7.30 p. m., therefore after sunset, and the village was not in possession of the victor till about eight at night. The decisive action at St. Private may, therefore, very properly be counted among the night combats, but we prefer to discuss the combats about this village together in another connection.

However, it is certainly appropriate to consider here the events of the battle *after* the storming of St. Privat. Even while the possession of the village was still being contested batteries of the Guard were coming into position on the high ground south-west of St. Privat, and these were gradually reinforced by batteries of the X corps, so that after night fall 134 guns formed at this point a strong artillery mass. Of these, 68 guns fired on the great French artillery line, standing in front of the stone quarries of Amanvillers, and 66 directed their fire on the enemy's troops near Amanvillers and on the village itself.

On the French side lieutenant-colonel De Montluisant had deployed in front of the stone quarries of Amanvillers ten batteries of the 6th French army corps, which were joined by two

batteries (12 pounders) of the army reserve artillery. In rear of Amanvillers batteries of the 4th corps were firing; they were joined by two horse batteries of the 3d corps, and finally the artillery of the Grenadier Division of the Guard also took part, while at the last four horse batteries of the Guard came up, but only two opened fire. In sum total only 22 guns of the French artillery of the Guard opened fire, and expended 660 shells and shrapnel, a comparatively small amount of ammunition.

There was therefore, even on the French side, in the last moments of the battle after sunset, a great mass of artillery in action, and the thunder of the guns resounded in very marked tones.

North-east of St. Privat a second German artillery meanwhile developed, viz: five Saxon batteries, the artillery of the 20th infantry division, and finally two more batteries of the Saxons. These eleven batteries also fired on the French artillery in front of the stone quarries of Amanvillers, and on the French columns retiring toward the valley of the Mosel.

The French had the advantage in that the burning village of St. Private lit up the vicinity and showed the German troops to the enemy; the Germans set Amanvillers on fire too, but without gaining any advantage thereby.

More than 300 guns thundered away till far into the night and made an appropriate finale to the grand battle. Behind the French artillery lines dark scenes were enacting. French train wagons flew at a galop back towards Metz, and were joined by cantiniers and others, which accompany the French troops in such great numbers. The gait of the flying became faster and faster until finally they ran down everything in the way. Infantry subdivisions without officers were carried along in the current, and the mass of stragglers (the French, polite as they are, call their coffee-coolers *trainards*) soon mixed with the flying crowd, as well as separate horsemen.

Like an avalanche the swelling stream moved on, and the disorder was very great. In vain the French officers, revolver in hand, attempted to block the way of the frantic mass; in vain the braver ones, that resisted to the last, called out: "The Guard is coming! Long live the Guard!" It was all in vain. Whoever opposed the torrent was run over. Soon the fleeing inhabitants of the burning villages joined the current. to increase the confusion, men with the remains of their household goods, crying graybeards, everywhere nothing but sorrow, fear and distress.

Some of the vehicles were upset and filled the ditches along

the road, and the contents were scattered about, frightened horses without riders went tearing along the road.

At first this panic did not affect the fighting troops, but the longer it lasted, the more contagious it became. Dick de Lonlay says (Part IV, p. 392): "Whether the gradual cessation of the noise of battle led to the belief in ultimate defeat, or the extreme fatigue of the day made even the coldest impressionable, certain it is that the fear of imminent danger spread among the soldiers and all took the road for Metz, persuaded that the enemy's scouts would not be long in putting them to flight, and resigned to their fate, like men who had done their duty.

"Indeed, if a hostile party had accidentally thrown itself on the rear of the 6th corps, it would have taken the most valuable booty of the campaign: immense quantities of artillery and administration material, thousands of men and horses; for those who might have wished to defend themselves would not have been able in the press either to draw their swords or cross their bayonets."

The friends of night combats will probably say that a splendid opportunity for grand results was here offered to the Germans. Those who have that idea, however, must not forget that between the flying masses and the Germans there were over 100 French guns pouring out a hellish fire. Moreover, the rear-guard of the 6th French army corps behaved splendidly; it retired very slowly, and held the victor, who had suffered fearful losses, well in check. Later on the Zuaves and the three Grenadier regiments of the Guard formed a protecting wall, behind which all that was no longer fit for battle could run off.

The main point, however, was the fact that the victor of St. Privat himself was entirely worn out. To be sure, the most advanced brigade of the X corps could have advanced still further, but what could a single brigade do against a hostile superiority in the dead of night?

Let us return to the Germans. Two batteries of the X corps were so bold as to pull out from the great artillery line southwest of St. Privat and unlimber on a height lying farther to the east and front, in order to take the French artillery at more effective range. But they soon found themselves attacked in flank by infantry subdivisions of the Division Cissey of the 4th French corps. The leading battery had to wheel towards this infantry and by energetic firing, assisted by other batteries, threw it back. All subsequent efforts of the French were repulsed in the same way; each time they retired with heavy losses.

Meanwhile the 20th infantry division had begun to advance in the direction of Roncourt and marched between St. Privat and Ste. Marie aux Chênes. The 40th infantry brigade then advanced along both sides of St. Privat; the 7th and 8th companies of the 17th regiment met with considerable resistance in the village. Parts of the 17th and 92nd regiments, and the 10th *Jäger* battalion turned toward the Jaumont forest and opened fire; the Jägers directed their fire particularly on the hostille artillery. Complete darkness alone put a stop to this firing. A serious attack was not made,—outposts were established eastward of St. Privat. The 40th brigade did not have any further serious engagement, as is distinctly proven by its small losses.

On the part of the Saxons, in the advance of the 48th infantry brigade from Montois to Roncourt, the 9th, 10th and 11th companies of the 106th regiment were sent against Malancourt. and had moved out from that village to the south under light skirmish fire. The 1st battalion and the 12th company of the 106th regiment attacked the Jaumont forest, the western edge of which was held by the French, from the direction of Roncourt.

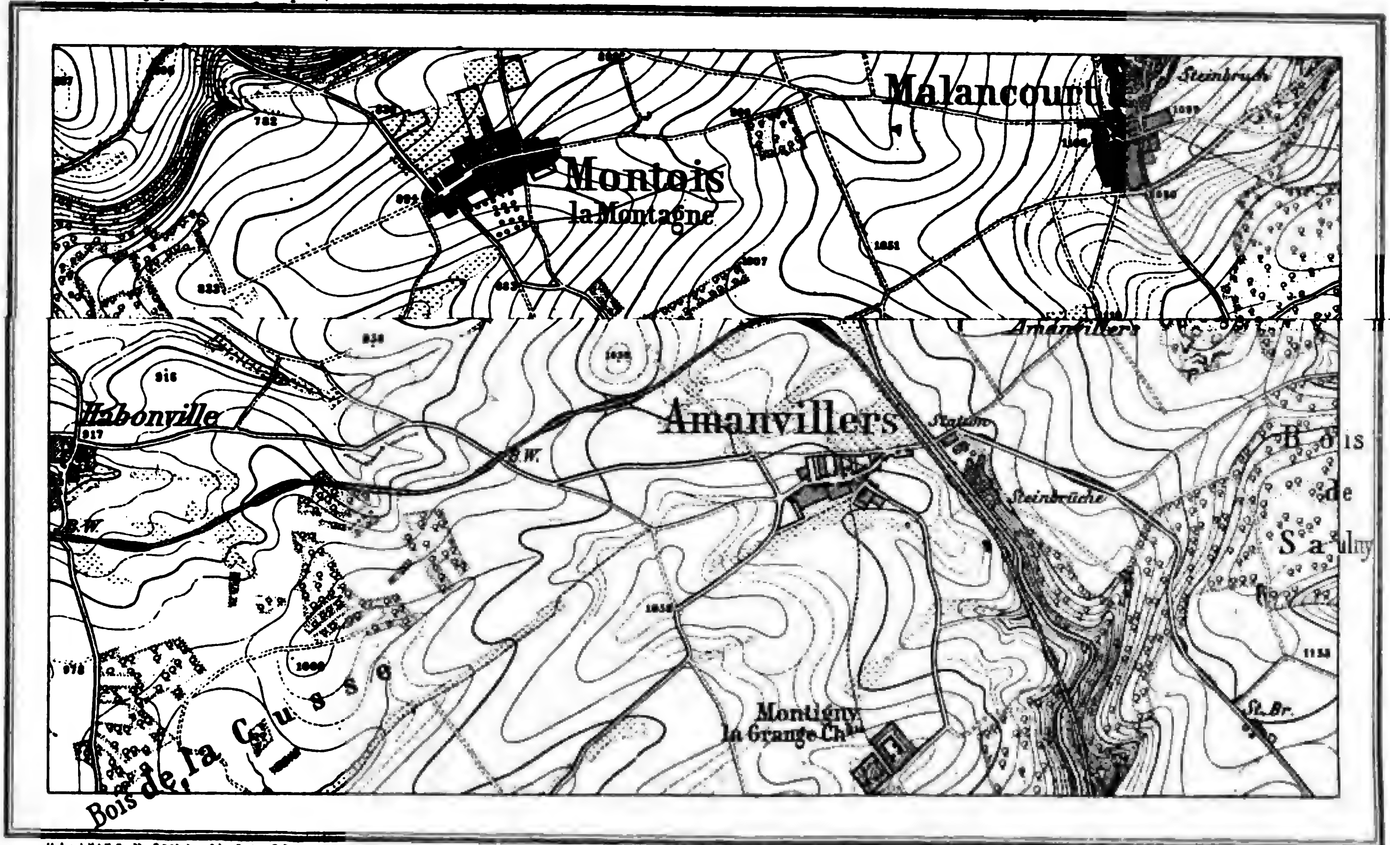
Opposed to the Saxons were the French regiments of the line numbers 4, 9 and 10, and the 9th Chasseurs battalion. These troops had fought at Roncourt, but, on account of the great superiority of the Saxons, had retired to the edge of the forest of Jaumont. Portions of the French as rear guard occupied the edge of the forest and the embankment of the road Roncourt—Malancourt in front of it. Advanced lines of skirmishers lay hidden behind walls and in depressions in the ground.

A lively combat took place here, and immediately after the five Saxon companies, supported by the third battalion of the 107th regiment, advanced and stormed the road embankment. After a short pause they continued their attack and gained possession of the edge of the forest without resistance, after the 1st Saxon horse battery took that point under effective shrapnel fire.

Then the Saxons pursued the enemy; their left flank struck the stone quarries of Jaumont, which were occupied in force by the enemy. The Saxons, assisted now by the 9th, 10th and 11th companies of the 106th regiment from the direction of Malancourt, forced their way into the stone quarries and captured a gun, but had to give it up again when the French made a sudden counter attack. Finally, the French had to give way, however; parts of the 10th and 12th companies of the 107th regiment followed them as far as Bronvaux.

The fight in front of the road embankment was at first very

Zu Kunz, Kriegsgeschichtliche Beispiele, I. Heft 2.



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lively, so much so that the 13th Jäger battalion and the third battalion of the 103d regiment were brought as reserve from the vicinity of Roncourt, but did not get seriously engaged. The 13th Jäger battalion supposed the stone quarries were still in the hands of the French and advanced against them in battle formation; a battery shelled the forrest; not until the signal "The 4th brigade stop" was made, was the mistake corrected.

It may be interesting to relate a few incidents. As the leading battalions of the 40th infantry brigade advanced on St. Privat, it was not yet known among the troops that the village had already been stormed by the Saxons and the Guard. The companies of the Brunswickers rushed forward with loud hurrahs, and did not notice the victory was already won at this point until they came upon the troops of the Prussian Guard assembling on the western border of St. Privat. All the more cheerfully did the infantry of the Prussian guard respond to the hurrahs of the Brunswickers, however, for their small subdivisions, mostly without leaders, with many French prisoners in their midst, now saw that the fresh troops secured the victory. Regiment number 17 made 430 additional prisoners and regiment number 92 about 120 in St. Privat.

In the further advance of the 17th and 92nd regiments and the 10th *Jäger* battalion the object was to attack the great artillery mass in front of the stone quarries of Amanvillers. The most advanced scouts arrived within 500 paces of the enemy's guns (in all probability they actually got considerably closer) but came under the fire of their own artillery, stationed north-east of St. Privat. They were about to inform these batteries of the situation, when, at 9 p. m., the order came to stop all further advance.

When a military leader like Prince Frederick Charles renounces the doubtful chances of a night combat, his action speak for itself and requires no comment.

While the right flank of the 40th infantry brigade turned towards the great artillery mass of the enemy, the left wing threw back several routed French subdivisions towards the forest of Jaumont and then met with energetic resistance at the edge of the woods, but soon found that here too only retiring infantry was making a brief resistance. But the German artillery posted north-east of St. Privat now shelled the forest and its edge with great energy. The commander of the 92nd regiment sent an orderly to the firing batteries to inform them of the advance of the infantry, but allowed his companies to advance beyond the

limits of the woods in order to avoid losses from the shells. In this way the left wing of the 92nd also moved towards the great French artillery mass, but received orders, in the vicinity of Ferme Marengo, to cease firing.

Although the battle of St. Privat ended at 9 p. m., hence lasting only a short time during the darkness of night, we see presented all the usual characteristics of night combats: storming a village already taken, firing on one's own troops with the artillery etc. Such misfortunes cannot very well be avoided.

A panic resulted only on the French side, but there on a grand scale.

[Trans. Captain JOHN P. WISSER, 7th Artillery.]

INTRODUCTION TO THE STUDY OF THE WAR BETWEEN TURKEY AND GREECE.

BY C. F. VON DER GOLTZ.

Militär-Wochenblatt.

I.

Now that the war between Turkey and Greece has closed, it will not be inappropriate to discuss the main object and the original plans of campaign of the Turks, as they are already a part of history, and may be of use for interpreting the events which followed, and which have excited so deep an interest among the officers of our army.

The first plan proposed for the concentration of the Turkish army on the Greek border dates from the year 1886. The situation at that time was quite similar to the present. To be sure, there were armies ready to take the field along the Bulgarian and Servian frontiers; but in the end all eyes were turned to the southern theater of war; where only was there a war in prospect, and where only did important encounters take place, which gradually assumed the form of actual battles. The army of operations organized to oppose Greece then had about the same strength and composition as the present one at the beginning of operations. The artillery is somewhat stronger this time, for it has been greatly increased in the Turkish army since then; the same is true of the cavalry, since the regiments of the line available for this purpose, which were required at that time to build up two armies, in this instance had to form only one.

The plan proposed was based on the assumption of Greek superiority at sea. This was publicly admitted eleven years ago by the systematic and apparently deliberate neglect of the Turkish fleet.

Should the Greeks succeed in prolonging the war, the superiority, which is even more pronounced today than it was in 1886, could certainly, if the fleet were handled with energy, make itself felt. They would be able to take one after the other the islands of the Aegean Sea which are still in the possession of Turkey, to control the Turkish coast, to excite disturbances here and there in the maritime districts peopled by Greeks, and to cut off the Turks from outlet and sea communication to the westward. All this

had to be taken into consideration first of all, and could be prevented only by a *rapid* aggressive movement.

As is well known, the theater of war on the Turko-Greek frontier is divided into two distinct districts, separated from each other by the high chain of the Pindus Mountains: Thessaly in the east, Epirus in the west. Between the two there is at present only one direct communication, the mule-path over Mezzovo, through the celebrated Djan-Kurtaran Pass. During a General Staff *ride of instruction*, conducted by me in that region in 1894, a line was laid out in recognition of this evil, for a high road passing around the north of the Lake of Janina, over Dovro and Tschepelovon to Grebena, but it certainly has not been possible to complete this difficult construction by this time. The complete separation of these districts, therefore, exists today.

In the western theater of war, that of Epirus, Turkey is forced to the defensive by the character of the country; since an offensive campaign would find nothing on which it could work, but would end by coming to the Gulf of Cornith, without having had any effect on the general progress of the greater events of the campaign.

Consequently, only two weak divisions were assembled in Epirus in 1886. They were to limit themselves mainly to the defense of the capital, Janina, but it was proposed at the same time to evacuate not only Prevesa, which is so open to an attack by sea, but also the position opposite Arta and those near Luros (between Arta and Prevesa). In this proposition the fact was taken into consideration that the fall of Prevesa, where a mass of artillery material was stored, would appear to the world as an important Greek victory. The isolated position of the place, which could be succored from the rear only and that with great difficulty, the weakness of its works, and its easy accessibility from the sea, rendered such a result in case of a prolonged war quite possible, if not probable. Moreover, the Turkish positions opposite Arta, and the others scattered over the southern portion of the province, would be in danger of being separated from the reserve at Janina, in case the Greeks marched on the road along the left bank of the Arta northward as far as Kalarrytae, and then crossed the river over the Plaka bridge, pushing on toward the capital of the province from that point. The timely evacuation of southern Epirus would also have economized troops, which, if required, could have been drawn to the eastern theater of war, without thereby seriously endangering the safety of Janina, provided proper preparations for defense had been made.

Of course, at the end of the war, as soon as a decisive victory should be obtained in Thessaly or Attica, Epirus would be freed from the enemy by means of the troops that would then became available. In the meantime, outside of the works of Janina, the invasion could have been energetically resisted by the auxiliary forces of the South Albanian Beys, called *Mouvéné*, 25 weak battalions, of about 400 men each.

It should be remarked, however, that this part of the plan was never officially approved. The danger, after the conclusion of peace, of never again acquiring a district which had once been evacuated, induced the government to hold on even to these advanced posts. Now that Greece is the only opponent of Turkey, the latter may permit herself the luxury of a superabundance of forces in Epirus, and on that account too, in the defense of the entire region, such a course may be justifiable. The timely evacuation of Prevesa would have been advantageous under any circumstances. The troops there stationed are imprisoned, and are altogether lost so far as the rest of the operations on land are concerned.

The Turkish offensive movement had to be first towards Thessaly and then into the Attic Peninsula.

The main strength of the Turkish southern army was therefore concentrated along the Thessalian frontier. According to the plan of campaign it was to consist of six infantry divisions and a cavalry division. As a matter of fact, in 1886, a seventh infantry division was organized and sent to the front, but the cavalry division was wanting.

On account of the great difficulties which the character of the country in these regious places in the way of armies, all measures were naturally much more hampered by the lay of the ground than is the case with operations in the west of Europe, where the roads are good and numerous.

The frontier follows a chain of mountains, beginning at Platomona, on the Gulf of Salonica, but separated both from the great mass of Mount Olympus on the north, and that of Mount Ossa on the south, by deep valleys, toward which its sides fall off in steep slopes. On the north is the ravine of the Kanalia, flowing eastward to the sea, and that of the Davadere, flowing towards Elassona. On the south is the deep gorge of the Salambria.

The jagged summit of Platomona rises precipitously towards the conical peak of Analipsis, nearly 4550 feet high, and follows, with many windings, a generally westward direction for about 25 miles to the deep cut of the Meluna Pass. It then turns to the

south at a short right angle. In this way it encloses the plain of Larissa, 18½ miles square, which is separated from the sea by Mounts Ossa and Pelion, so that on three sides it is surrounded by high mountains, while to the south lie the moderately steep group of hills of Kynoskephalae (Kara Dagh). Broad slopes connect it on that side with the other portions of the plains of Thessaly, in the directon of Volo and of Karditsa and Trikkala.

The boundary line continues, turning at first once more to the westward, then north and again west, sweeping around the neighboring basin of Trikkala and Kalabaka in a wide curve, and striking Mount Pindus at Mezzovo.

In 1886, the basin of Larissa was the principal point of assembly for the Greek forces. It was assumed that the latter, in case they should attempt an invasion, would very probably reach the coast at the mouth of the Salambria through the Vale of Tempe, long noted for the beauty of its natural scenery, and then, accompanied and supported by a portion of the fleet, follow the coast towards the north. This is, indeed, the same road that the Romans under Emilius Paulus took on their way to the decisive battle of Pydna against King Perseus.

Strong advance guards, pushed out towards Rapsani and to Lake Nezeros, indicated this purpose of the Greeks at that time.

On this was based the plan for the Turkish attack, which was to begin the moment war was declared. The Greek advance, in case it was actually planned, required similar promptness in its execution to have any chance of success. The next question was whether it would be better to descend to the plain of Larissa from the north, i. e. over the first, or westwardly trending, spur of the mountains, or from the west, over the second, or southwardly trending, spur. The former was the more convenient and the safer, but the latter promised greater results. In case the advance was made from the north it would strike the Greek front, and the Turks would be compelled to cross in presence of the enemy on the plains, first the Xeragis (or Xerias), then, at Larissa itself, or between that city and Tyrnavos, the Salambria; and although they might indeed defeat the enemy and drive him back, they could not destroy him. The escape of the Greeks could not in that case be prevented, and this—so it was decided—would be disadvantageous for Turkey in a military as well as in a political sense, for, as a consequence, there would be a prospect of renewed resistance in the Othrys mountains, of a continuation of war, of maritime victories of the Greeks, and, in case of a war of considerable duration, of further political complications, either with

the other Balkan states, or with the endorsers and protectors of threatened Greece.

For these reasons the advance from the west was regarded with more favor, especially as there is here the additional advantage that the chain of mountains bordering the plain is twice pierced, namely, by the Xeragis in the defile of Beydermen (Bey-Deghirmen, also called the defile of Damasi or Tshaihissar), and that of the Salambria (Peneios) in that of Kalamaki. Both (unfortunately I was unable to see them myself) are said to be practicable; indeed, there is in the former a carriage road on each side of the river. Moreover, the simultaneous and rapid advance of considerable forces seemed much easier to effect in this locality. The fact that the possession of both these defiles would have to be accomplished on Greek soil was recognized, but the Greek subdivisions pushed out to the front at that point were much weaker than those sent to the north. It was also assumed that the forces of the enemy stationed at Trikkala and Kalabaka would be drawn to this point, in order to act against the right flank of the advancing columns, unless they could be held by a simultaneous attack from Diskata or Grebana. Neither of these possibilities, however, made it necessary to give up the original plan.

The following deployment was therefore proposed:

1. The 1st and 2nd Divisions, with headquarters at Karya (Koskioej) and Elassona, to secure the frontier from the sea to Meluna Pass, to observe the Greek advanced troops at Rapsani, Nezeros and Tyrnavos, and, by means of a subdivision detached to Platomona, to guard also the road running along the coast.

2. The main army, consisting of the 3d, 4th and 5th infantry Divisions and the cavalry Division, to be concentrated in a narrow space in the portions of the Turkish mountains projecting far to the south in the vicinity of Domenik and Damasi, occupying the heights on both sides of the defile, with their advance guard on the frontier at Beyderman in the Xerias valley.

3. The 6th Division at Diskata to constitute an isolated right wing, and at the same time to preserve, as well as might be, communication with Epirus.

From this deployed position the concentric advance on Larissa was to begin, and the decisive blow was to be struck from the *west*, the divisions of the main body, the 3d, 4th and 5th, advancing through the valley of the Xeragis into the plains, at the same time forcing their way from Damasi through the Revend Boghazy to the Samabria, and along this stream through the

defile of Kalamaka. Of course, the heights between the Xeragis and the Salambria, as well as those of Gunitza, lying close to and on the south side of the latter stream, would also have to be taken. In this advance the Xeragis would be crossed on Turkish ground, while the Salambria would have to be bridged at the outlet from Revend Boghazy.

The 6th Division was to accompany the attack and advance with energy against Trikkala, in order to hold the Greek troops posted there, and to prevent them from interfering with an attack on Larissa. The 2nd and 1st Divisions were also to advance, but not until after the appearance of the main body at the outlets from the mountains, and then, without pressure, to keep the enemy within reach. The road over the Meluna Pass and the Daria Getshid (Daria Pass), further to the eastward, were at their disposal.

In this way the Turks hoped to fall upon the left flank of the main army of the Greeks, to take it by surprise, and to force it to fight with its front to the west, so that retreat on Volo or over Pharsala to the Othrys mountains would be cut off. To effect this, the cavalry Division, as soon as the main body of the army debouched on the plain, was to be brought up behind the advanced troops, in order to move out and attack the enemy to the south of Larissa. The entire plan was therefore dependent on the result of the battle with the enemy's main army at the very beginning of the campaign. If operations were successful, this question would be decided the third or fourth day after the declaration of war.

Should the Greek army be cut to pieces, or forced into the ravines of Mounts Ossa and Pelion, the way to the interior would be open, and without the assistance of the army it would hardly be possible to wage an energetic national war.

Of course, the plan also took into account the possibility that the retreat of the Greeks from Larissa might be successful, as has actually been the case. Four other lines were in that case available: the difficult Mount Othrys with the Furka Pass on the old Greco-Turkish frontier; the defile of Thermopylae, farther to the south; the mountain chain of Phthiotis, rising behind it, and finally, the defile on the Lake of Kapais, which it would be difficult to turn. It would be premature, however, to discuss these possibilities now, since an accidental agreement with the actual plans of the Turkish commander might lead to disageeable consequences.

In conclusion, the plan called attention to the fact that, without

the assistance of the fleet, the complete subjugation of Greece was impossible, and earnestly recommended its reconstruction on an efficient war footing.

[Trans. Captain John P. Wisser, 7th Artillery.]

HOWITZERS AND MORTARS FOR FIELD ARTILLERY, TO SUPPLY A NEED OF CURVED-FIRE.

By Tiedemann, Major and *Abteilungs-Kommandeur* in the Posen Field Artillery Regiment, No. 29.

Jahrbücher für die deutsche Armee und Marine, December 1897.

[CONCLUSION.]

C. A GENERAL VIEW.

Of late years there have been but few reports published of test shooting of howitzers and mortars; especially has it been left undetermined as to what change as regards facility of observation and rapidity of fire may be the result of the larger cloud of smoke from bursting shrapnel. It becomes a matter for grand tactics therefore to decide, on the basis of experiments at home and the reports of those abroad, whether troops not engaged and under cover shall be cannonaded. If so, it is then a question to determine whether the new field guns will be sufficient. It is plain, however, that these new field guns are not as good as the former ones for attacking concealed targets; for the new guns have a greater initial velocity, a flatter trajectory, a greater probability of hitting vertical targets, and along with this a greater variation in the point of bursting for the same time fuze. Thin shell will therefore give less results against concealed targets than the older type of field guns.

In the last few years there has been much progress in gun construction, and advantage might be taken of this in making a new curved fire gun, to improve both piece and carriage; the piece could be made lighter, a high total pressure obtained with a small maximum pressure, apparatus might be devised to permit simultaneous loading and aiming, and the projectile weight be improved. A howitzer or mortar might thus be obtained that would shoot with more accuracy than any yet constructed. It may be that the reports of the tests of those now in use are too few, and it is certain that the arrangement of the target has not been a reasonable one for curved firing. The 12-cm. (4½-inch) howitzer has indeed shown itself superior to the other guns but has nowise come up to the hopes and expectations of its effectiveness that were entertained.

The value of a mortar or howitzer depends upon, (1) the nature and magnitude of the demolition it effects, (2) its range, (3) the time required to serve it. To cause considerable demolition, a larger caliber is necessary than that of the field gun ; the nature of the demolition calls for a curved fire gun ; the range must be large, and the time required to serve the piece small. In general these conditions require that the curved fire piece shall as far as possible resemble the field gun. The howitzer and mortar are intended to share in the battle. which will hardly last through a single day, their part being the cannonading with shell and shrapnel of field intrenchments with their overhead cover. Howitzers and mortars thus far constructed when firing shrapnel, have shown but little power against men under cover behind a parapet. Probably shell carrying high explosives will here be chiefly employed, since the garrison of such intrenchments are screened from shrapnel by blindages. Not until this overhead cover was destroyed could shrapnel fire be effective, unless the curved fire guns took part in firing at troops in the open.

There is a lack of data as to the effectiveness of high explosive shell against the broad fronted but thin target which the echelons of the field trenches present.

D. HOWITZERS AND MOTARS FOR FIELD USE SHOULD BE ASSIGNED TO THE FIELD ARTILLETY.

A 12-cm. (4.72-inch) howitzer has not as yet been adopted in Germany for field use, and the foot artillery possesses in the way of howitzers but the 15-cm. (5.9-inch) caliber, a piece whose little mobility unfits it for use in the rapidly changing phases of a campaign.

Let us figure to ourselves the course of a battle as it develops between two opposing armies, of which one stands on the defensive and the other attacks. The fight will be opened by the field artillery, which coming up in large masses will seek to obtain a superiority over the enemy's artillery. The defense will have thrown up intrenchments along the greater part ot its front, but the attacker will not know at what points these are strong and provided with blindages. He may surmise that they may be stronger on the flanks, but he cannot be sure, and must expect therefore to find troops completely protected against a flat trajectory at other points along the front than those where he first supposed. It is necessary therefore that the curved fire cannon be as mobile as the field guns, in order that they may change quickly from place to place to be where they are most needed.

For this reason it might be well to keep them in reserve at first and not bring them into play until the artillery duel has been decided. They might then with a part of the field guns attack the enemy's infantry, while the rest of the field guns continued to hold the artillery in check. Assuming that the attacking side wins in the artillery duel, it will then generally be clearer where howitzers and mortars will be of most value; it may be at the start they haye been badly placed. It is necessary that these pieces should be able to collect rapidly at the decisive point, as well as to change their position along the line of battle. The heavy guns of the foot artillery could not do this; where they are first stationed, there they must be left, even it they accomplish but little.

The heavy batteries of the foot artillery are valuable for the defense of fortified places (as in December 1870 at Orléans, and in January, 1871 on the Lisaine, and in 1877 at Plevna); such batteries are of little value for the attack.

If lighter calibers than those of the heavy artillery are to be introduced, practice should be had with them in times of peace, that the troops may become familiar with them.

Major Leydhecker in the prize essay already referred to, wanted to take the necessary officers and cannoneers for the curved fire batteries from the foot artillery, and the drivers from the light artillery. Some of the reasons for this selection exist now as much as they did in 1887 when this paper was published. However we cannot agree with this opinion of Major Leydhecker. It has been shown that howitzers and mortars on account of their low rate of fire must in general seek cover. At certain times, however, they will have to engage along with the field guns in the artillery duel or in the attack of troops not under cover. The light mobile howitzer batteries will have to move as rapidly as the field batteries, taking advantage of the cover the ground offers. The commanders of the howitzer batteries must be as trained as those of the field gun batteries in choosing ground, taking up a position, securing a good tactical point of view, and the like.

Now if these battery chiefs belonged to the foot artillery, it would be a long while before these officers acquired the requisite expertness, and this apart from the ability to ride which would be required of all foot artillery officers; for changes to and from the howitzer and mortar batteries would occur. If the same officers were permanently with these batteries, they would no longer be foot artillerymen. The fortunate separation of the

foot and field artillery which has now existed for twenty-five years would be done away with by the proposal of Major Leydhecker.

The length of service in the foot artillery is two years. If the men for the howitzer batteries were taken from this arm, it would increase the difficult task of properly instructing the cannoneers of the foot artillery, who are already required to learn the service of widely different guns; while if the men for the howitzer batteries belonged to the field artillery, it would mean merely instruction in the service of a second gun.

Furthermore the cannoneers of the howitzer batteries, like those of the field gun batteries, must be able to throw up works, must be acquainted with the care of horses, and understand saddling and harnessing. The task of the non-commissioned officers and men of the foot artillery would by this addition become even greater than it had been before 1872; for while the officers then passed from the field to the foot artillery and the reverse, the men of one service were never required to learn the greater part of the duties of the other branch.

The number of field guns should not be diminished on account of the introduction of the 12-cm. howitzer, for the former would in that case be unable to do their part when opposed to the superior field artillery of the enemy.

It is necessary that in time of peace the howitzer batteries should receive practice, and for this they must be drawn by horses. They must be easily taken over all kinds of country, and be as mobile as the field guns, and from this condition the number of horses required by each piece would be determined.

E. ADVANTAGES AND DISADVANTAGES ATTENDING THE INTRODUCTION OF CURVED FIRE GUNS INTO THE FIELD ARTILLERY.

The simplicity and uniformity in the arament, equipments, and ammunition supply of the field artillery, brought about after great efforts, have been hitherto carefully maintained. If howitzers and mortars were introduced, these and other advantages would disappear, and many disadvantages would result. It seems advisable therefore to note here the changes of a positive and negative character that would ensue, to weigh against each other, and determine which preponderates.

I. DISADVANTAGES.

It is undeniable that a number of disadvantages are involved in the introduction of howitzers and mortars. These in the main are as follows:

By the existence of two pieces, different in their service, the instruction of the cannoneers would be rendered more difficult, and this drawback is enhanced by the fact that the period of service is only two years. Since one piece fires only with flat trajectory and the other chiefly at high angles, the laying of the guns would be entirely different, and right here the greatest difficulty would be encountered. It seems essential nevertheless that if not all, at least a part of the field artillery cannoneers should be instructed in the service of both pieces, that the men may be interchanged among the batteries, when great losses require it.

Again, the equipment of the field artillery would no longer be uniform, for the cannon would differ in kind and caliber; yet the men would have to be familiar with the equipment of both guns.

The ammunition supply at the guns and in the reserve would become hetrogeneous, and in many ways the ammunition might be interchanged with very unpleasant consequences.

The piece being heavier, the ammunition supply could not be so large, either with the battery or in the ammunition column, unless the supply column were unduly increased. In spite of the lower rate of fire of the curved fire guns (which is another disadvantage), the small supply of ammunition would make itself felt, as for example, when a battle was protracted for more than a day, and it was desirable to keep up the fire of the curved fire batteries during the night and perhaps on the second day. This might occur when the troops were blocked by a fort that resisted assault.

A 12-cm. caliber requires more physical exertion and more time to bring up and load its projectile, and since rapidity of fire is imperative in the field, there is a danger either of the cannoneers soon becoming exhausted, or of the rate of fire being too slow. The fire will be retarded in any case by the indirect method of laying to which the curved fire guns must resort.

Since chiefly on account of their slowness of fire, the curved fire batteries, unless behind cover, cannot engage in a duel with the field guns at decisive ranges, it follows that in a battle in the open country the curved fire guns are not equally good for all purposes. They have rather the character of special batteries, to be used preferably against certain targets. As will be shown later, the mortar batteries possess this character in a higher degree than the howitzer batteries. In general, the latter can better take part with the field guns against infantry than the

former, especially at long ranges. However it must even be looked upon as a defect that a part of the batteries present with an army are not so good as the rest against the principal targets.

At the end of the eighties the firing of shrapnel and its observation, when testing howitzers and mortars, was very unsatisfactory. Since then shrapnel has become easier to observe, and if the shrapnel and shell are kept of the same weight, it is probable that both the results and their observation will be improved.

It is an inherent defect in the howitzer and mortar, and especially the mortar, that they are unable to defend themselves against an enemy at short range. Sudden attacks from cavalry and from infantry at close hand are certainly to be looked for, yet it must also be borne in mind that the mortars and howitzers will likely be in at important points and that enough of other troops will be at hand there to protect them.

As the curved fire batteries are designed to drive the enemy from his points of support, against which they alone are adequate (at least this is to be inferred from their adoption in France and Russia), it follows that they should be saved up for this purpose, and therefore be covered as far as possible from the fire of field guns. If they must come into action without finding such cover, they should engage at the decisive point without regard to the losses they suffer, however great they may be.

The firing regulations for howitzers differ in many respects from those in force for field guns, and these differencs by the complication they introduce, would make it difficult for the cannoneers to become throughly accustomed to the firing rules.

II. ADVANTAGES.

There are very important advantages to counterbalance these objections to the introduction of curved fire guns. First of all there is the better effect against concealed targets. For the purpose of comparing the curved fire gun and the field gun, we will take the results of 19 firings of the field gun in which 938 shell were fired using the time fuse, and compare the relative number of hits with that of the howitzer and mortar firings, given on pages 82 and 83 of the October issue [Pages 30-31 of the January-February number of the *Journal*]. The field gun in this case was fired under war conditions at ranges from 1900 to 3000 meters. The number of hits from the field gun is taken as ten. In the case of the curved fire guns only the hits under *d*' of the tables are considered, which were the hits in the targets protected against the steepest angle of fall. The hits under "*a*" "*b*" and "*c*" of the tables are not taken into account. With the

shell of the field guns on the other hand the protection was against an angle of fall of 22°, in some cases of 25° and 35°. The firings from the curved fire guns were corrected by observations taken at the target, the field gun firings were under war conditions, and hence a comparison is not without serious objections. It is to be remembered, however, that the shell were in each case preceded by accurate trials with percussion shell, so that we may consider at any rate that equal weights of metal from each type of cannon were fired under like conditions. The total weight of metal in the case of the shell amounts to 7035 kg., for the shrapnel of the curved fire guns 709.5 kg.

Of the 19 firings of the field gun, 17 took place in summer and 2 in winter, but in good weather; while in the firings of the curved fire guns there was an almost impenetrable fog for a time in the winter firing; and a violent head wind at another time in summer blew across the range towards the left, and this during the firing of the 12 cm. howitzer at 1980 meters.

TABLE VI.

Kind of Gun.	Range.	No. of round (time fuze.)	Kind of Projectile.	Relative No. of hits.
Field Gun	1900-3000	938	Shell	10.0
12-cm. howitzer	1500	10	Shrapnel	21.4
12-cm. howitzer	1980	10	Shrapnel	10.0
15-cm. mortar	1500	5	Shrapnel	16.4
15-cm. mortar	1975	6	Shrapnel	15.0

These numbers are very much in favor of the 12-cm. howitzer. There are still other advantages that may be adduced.

The curved fire guns, especially by the use of reduced charges are enabled, through their great angle of fall, to destroy overhead protection by using shell, even when such protection would be adequate against the fire of shrapnel from curved fire guns.

Moreover to be equipped with curved fire guns makes an army capable of executing independently and swiftly all the work that falls to it. This is the more important since Germany, in the event of war with its eastern and still more with its western neighbor, would find close to its frontiers well prepared works against which a rapid success would be of great value. Hence guns must be introduced which best serve this end, and which are able to concentrate rapidly against a point whose possession would be of importance in the first line. But not only against forts blocking an entrance would the curved fire guns be of great

value, but likewise in the investment of a fortress they would prove superior to the field gun. Hitherto the defensive, with his fortresses secure from the shrapnel fire of the field guns, has been able to complete the arming of his permanent works and the preparation of the field of battle. These preparations would be interfered with, if the attacking side possessed curved fire guns. Hence a decisive result would be attained more speedily.

In the attack of a position occupied by us by one of the possible enemies we have mentioned, as well as in attacking a position that they may hold, we have to reckon upon curved fire being employed against us. If these batteries are behind cover, and not attainable by field guns, we are altogether without means of replying to them, unless we too have curved fire guns. This presumes that the curved fire guns are more effective than field guns using shell.

Another advantage of the curved fire batteries lies in the greater efficiency of their high explosive shell against villages whose houses have very thick walls. The high explosive shell of field guns will penetrate indeed a weak wall, but used against a strong wall their sensitive percussion fuzes explode the shell before it has penetrated sufficiently. It is true, that keeping the same fuze with the curved fire gun, the shell would still burst prematurely, but in this case we can count on the action of the heavier charge of explosive which the shell carries.

When the infantry advanced against the enemy's intrenchments, the curved fire guns could more easily shoot over their own troops, and there would also be less variation in the point of bursting of their projectiles. It is true, the difference between these variations under like conditions is not very large, but an error in elevation in firing would change the range of the long guns much more than that of the curved fire guns, much to the advantage of the latter. This fact also speaks in favor of the curved fire guns in firing over their own troops when the latter are close up to the enemy's works. The curved fire guns can keep up their fire to the very last moment of the assault by firing over the works at reserves that may be hastening up to the intrenchments, and if the assault fails the curved fire guns can come into action earlier than the field guns and seek to check the pursuing enemy.

When space is lacking for a development of all the batteries, the ground sometimes may permit of two lines one behind the other; in this second line, the curved fire guns might be placed

if the range did not thereby become too great. Supposing the first line of artillery established at 3000 meters, a second line could readily be formed of howitzers, as they have a range of more than 5000 meters. This wide range would give them more freedom in the selection of a position. Finally we must not omit the fact that in cannonading infantry behind intrenchments, rapidity of fire is after all not a very important matter, and even the present field guns firing shell spend from ten to twenty rounds and more before they can begin firing with the time fuze. The howitzers on the other hand shoot on the average about thirteen, with reduced charges eighteen rounds, before beginning with the time fuze.

The chief advantage in the adoption of the curved fire gun, we repeat, lies in the fact that in many ways it hastens the decision of a battle; and since the advantages to be gained from this outweigh the disadvantages, the introduction of such a piece seems to be commanded.

F. THE CHOICE OF THE KIND OF PIECE, THE CALIBER, AND THE CARRIAGE.

In the choice of the kind of piece, we have howitzers and mortars to consider. The former are to be preferred because they are capable of defending their own front; further by selecting a caliber of from 10 to 12 cm. (3.9 to 4.7 inches) ranges up to 6000 meters are secured with a comparatively short time of flight for the projectile, and a sufficiently large quantity of ammunition can be carried along without making the piece too heavy and unwieldy or the columns too long. If the projectile with this caliber does not weigh more than from 16 to 20 kg. (35 to 44 lbs.), the service and management of the piece is much easier than that of the 16-cm. caliber whose projectile weighs about 40 kg. (88 lbs.). A caisson in the first case could carry about twice as many rounds as in the second. The supply of ammunition to the guns in the firing line would also be facilitated, for notwithstanding the greater rapidity of fire, the caissons behind the pieces would not be so soon emptied as with the 15-cm. Under like conditions and for the same range, the howitzer imparts a greater muzzle velocity than the mortar to its projectile, and is more accurate, and as it can be loaded and aimed more quickly, it has a greater rapidity of fire. The howitzer is more independent in battle for with an increased powder charge it can fire with a flat trajectory and take part in the general engagements; this is not the case with the mortar, mainly on account of its slow rate of fire, and its exclusive employment of high angle fire.

If for these many advantages the introduction of the howitzer seems indicated in preference to the mortar, it then becomes a question, whether a 12 or 15 cm. (4.7 or 5.9 inch) should be adopted. From a ballistic standpoint, the larger caliber is preferable to the smaller; all the advantages lie with the former from a purely artillery point of view. But as the piece is to belong to the field artillery, it must have mobility, and be able to follow the troops rapidly over all kinds of ground. A 15-cm. howitzer could not fulfill these requirements; it must be heavier than a mortar of equal caliber. The 15-cm. field mortar in a field carriage constructed by Krupp weighed as follows: gun, 450 kg. (992 lbs.); carriage with accessories 635 kg. (1400 lbs.); limber with ammunition—if it weighs as much as the 12-cm. limber—985 kg. (2171.5 lbs.); altogether therefore 2070 kg. (4563 lbs.) without cannoneers. The mortar is therefore 65 kg. (143 lbs.) heavier than the German field gun, and the 15-cm. howitzer would be notably less mobile than the mortar.

Of course a single projectile from the 12-cm. caliber is less effective than one from the 15-cm.; this follows from the fewer bullets which the smaller caliber can carry. This is perhaps counterbalanced by the greater rapidity of fire of the lighter piece. If five rounds are fired from the 12-cm. in the same time that 3 are fired with the 15-cm. then under the same conditions the effect of the five 12-cm. shrapnel will be the greater. In addition, the bullets from the 12-cm. howitzer have more energy than those from the shrapnel of the 15-cm mortar on account of the greater final velocity of the complete projectile for the same range. The 12-cm. howitzer appears therefore for its effectiveness and mobility to be the piece best adapted for use with the army in the field against fortifications of every kind, for it can support the field guns in grazing fire against vertical targets, and can act quickly and successfully by curved fire against covered targets. What Miethen said in the year 1680 still holds good to-day: "Howitzers among guns correspond to the queen in the noble and intellectual game of chess, which can be used everywhere in the game."

It would assist in the instruction of the men of the field artillery, if the carriage of the howitzer resembled as much as possible the carriage of the field gun. This requirement has been kept in mind by Krupp in the construction of his 12-cm. trial howitzer of 1886. Another condition that was observed was sufficient mobility for piece and caisson, so that when drawn by six horses and with the cannoneers seated, the battery could

everywhere follow the army in the field. This requires that the weights shall be not at all or but little in excess of the weights of the field gun batteries. The first trial piece constructed had therefore a total weight of 2100 kg. (4630 lbs.) distributed as follows, weight of piece 450 kg. (992 lbs.), weight of carriage without piece but with equipments 665 kg. (1466 lbs.), weight of limber with ammunition, 985 kg. (2171 lbs.). The piece was 11.6 calibers long, and had 36 grooves with increasing twist. The elevation bar was a circular arc with its center at the tip of the front sight; it was graduated in meters, and provided with a level for correcting obliquity in the position of the wheels. The carriage closely resembled that of the field gun, the wheels being of the same height, though stronger, as was also the axle. Elevation was given by a toothed segment. The carriage had a brake for travelling purposes, as well as to check recoil. The projectiles in the limber, shell and shrapnel, were of 20 kg. (44 lbs.) weight, and were stowed in two layers one above the other. With small elevations, the recoil averaged about 4¼ meters, with medium elevations from 1.6 to 2.0 meters; the wheels sank in about 9-cm. (3.5-inch), the trail up to 37-cm. (14.6-inch). With 40° elevation, the greatest recoil was 1.35 meters, the wheels sinking 28-cm. (11 inches) in the ground with 1.5 kg. (3.3 lbs.) powder charge, and the trail sinking in 30-cm. (12 inches).

At the Antwerp Exposition in 1895 there was a rapid fire field howitzer of the Schneider system. The "*Revue de l'armée belge*" published the following data in regard to this: "The recoil is so small that the piece can be fired continuously without running it forward. The piece can be used on any ground without platform, and the elevation can be rapidly changed. The gun itself is of steel with the tube grooved for the screw fermeture; it has a jacket, and four rings. The force of recoil is transmitted to the recoil cylinder through the jacket. The projectile has but a single rotating band and weighs 20 kg. (44 lbs.). The charge of 0.8 kg. (1.76 lbs.) of smokeless powder is contained in a metallic case. The bore has 36 grooves of uniform twist; the locking screw is twice interrupted. The piece is fired by a lock with firing pin, spring, and trigger, the latter having the trigger string fastened to it. A safety device makes it impossible to fire off the piece without entirely closing the breech. The initial velocity of the projectile is 300 m.

"The carriage has a hydraulic and a travelling brake, which latter can also be used to take up recoil, assisted by a prong on the trail. After firing, the hydraulic cylinder automatically

returns the piece to its first position. The whole cartridge weighs 23.7 kg. (52 lbs.); the piece with block, 455 kg. (1003 lbs.); the carriage 968 kg. (2133 lbs.); the limber loaded, 877 kg (1955 lbs.); in all, 2310 kg. (5093 lbs.)."

This weight which does not include the cannoneers is very high; it is 305 kg. (672 lbs.) greater than that of the German field gun, and this latter is about at the limit of mobility. The hydraulic brake is a feature of the Schneider Howitzer System that is easily injured. Moreover a rapid fire howitzer will hardly prove practicable for field use without a platform, for even if the gun recoils but slightly, the wheels will not sink evenly in the ground, and this will require a new laying. It might be that the disadvantage of a slow rate of fire, due to time lost in bringing the gun forward and loading and aiming it, could better be met by a *raqid-loading* gun rather than by a *rapid-fire* gun. If attention were also given to making the service of the piece easier, and to increasing the power of the projectile, then the main conditions would be met, which would be required in their curved fire guns by those states that mean to adopt a new flat trajectory field gun. For the new field gun will also probably be designed for greater mobility, power and rapidity of fire, than the gun now in use possesses.

The Krupp firm has already worked on this line. It has constructed a 12-cm. and a 10-cm. rapid-loading field howitzer. For the former, the weight of the gun is 450 kg. (992 lbs.); of the carriage without the gun but with its equipment, 555 kg. (1223 lbs.); of the limber loaded, 865 kg. (1907 lbs.); the total weight therefore, 1870 kg. (4122 lbs.) without the cannoneers. This howitzer is therefore 135 kg. (297 lbs.) lighter than the German field gun. The weight of the projectile is 16.4 kg. (36 lbs.); the powder charges in metallic cases are 0.430, 0,280, and 0.150 kg. (0.95, 0.62, and 0.33 lbs.) of smokeless powder, and impart to the projectile an initial velocity of 300, 225, and 150 meters. The piece can be elevated from $-5°$ to $+40°$. The maximum range is 6000 m., with shrapnel 5600 meters.

The carriage is built like that of the field gun; it has a detachable prong on the trail, and a crank to work a toothed segment for giving elevation, on the left cheek of the carriage. The piece is without preponderance and has a wedge breech-block. This is bored through in the direction of the axis of the gun, forming a chamber for the firing pin, which sets off by its forward impulse the cap in the base of the metallic cartridge. There is no vent therefore in the breech-block. The spring which actuates the firing pin is compressed by opening the breech.

The breeck-block can be secured so that it cannot be opened or the piece fired. An ejector throws out the metallic cartridge case and limits the withdrawal of the breech-block. Another device prevents the firing of the piece until the breech-block has been completely locked. With the breech-block properly secured, the gun can be moved without any risk.

A howitzer built in this way avoids many of the defects that belong to the older models, for its mobility is better than that of our field guns, its service has been made easier, the recoil has been lessened, loading and aiming are more rapid, and the rapidity of fire has been increased while its sphere of action has been enlarged. We can coincide therefore in the judgment of of LieutenantGeneral Müller, who says in his "*Wirkung der Feld-geschütze:*" "Undoubtedly in the future equipment of the field artillery unity of gun will be a prime consideration, yet not absolutely, for the field curved fire gun will still be retained."

It might be urged that the 10-cm. (3.9-inch) caliber, in every-way lighter than the 12-cm. (4.7-inch) howitzer, would prove a more suitable gun for field use. This probably is not the fact. With rifled guns the sizes of calibers are selected so far apart that a smaller caliber can equal in power a greater one only by expending a great deal of ammunition. If the 10-cm. howitzer were adopted instead of the 12-cm. caliber for the sake of greater mobility, it would probably prove very little superior to the present field gun, whereas the 12-cm, howitzer is much superior. Among the advantages of the 10-cm. howitzer might be mentioned the possibility of carrying along more ammunition; easier service of the piece; increase in the rapidity of fire as a result of lighter ammunition, and a less total weight of the piece. These advantages, however, are present in but a small degree, for the difference in weight of the projectile amounts to about 4½ kg. (10 lbs.), and the difference between the entire piece with ammunition is 43 kg. (95 lbs.). At the same time, there are drawbacks peculiar to the smaller caliber; the principal among these is its less power, which would make itself felt with both kinds of ammunition, especially with the shell carrying a high explosive. A 12-cm howitzer is therefore to be preferred.

G. PROJECTILE AND POWDER CHARGE.

The main object of a field gun is by a single shot to put as many living beings as possible out of the fight. This also holds true for the field curved fire gun. But here there will also be many targets to cannonade which on account of overhead cover

are entirely protected against shrapnel with the steepest trajectory. For this purpose penetrating power is requisite, together with an explosive action to destroy the shelter after having pierced it. Shrapnel without a high explosive cannot accomplish this; shell is required carrying as large a charge of high explosive as possible. For the field curved fire guns therefore both species of projectile are necessary,—shell to break up blindages and drive out those beneath, and shrapnel to attack men not provided with overhead cover, but sitting close up to the parapet and protected against an angle of fall of 22° to 35°.

The living targets are thus the men in the trenches, that is, broad but thin targets, generally not more than one man in depth. The method of attacking these targets would probably be as follows: The range is determined with shell, and then shrapnel with the time fuze is employed; previously by a distribution of fire along the whole line the men under blindages will have been driven out, and their cover destroyed. This assumes that the shell and shrapnel are of equal weight and have the same form, so that shrapnel fire can follow the shell fire without large corrections. (Unity of elevation and trajectory).

Having a large angle of fall and the angle of the cone of dispersion being not more than 30° with low final velocity, the point of bursting of the shrapnel must be rather high, in order to hit the greatest number of living objects with one shot. This increases the difficulty of observation. It seems a matter of importance therefore, that a shrapnel should be constructed, which, increasing the power of the projectile against covered targets, would permit the point of bursting to be placed lower, so that observations might at times be taken. Along with this there would have to be improvements in the time fuze.

To increase the power of the shrapnel against the broad but thin targets, a more violent explosive might be sought for, which would increase the angle of the cone to 50° or 60°, and at the same time give the bullets a greater velocity than that of the entire projectile before bursting. This might be secured perhaps by using in the chamber of the shrapnel a more violent explosive than gunpowder, as is done in the shell.

To secure a large and easily visible cloud on bursting the space between the bullets might be utilized as with the present field shrapnel. By these arrangements, the hollow interior free from fragments might be avoided when the projectile bursts.

If by these means the cone of dispersion became too great and there remained in the interior a space free from fragments, the

lateral dispersion and the thickness of distribution of the bullets might be regulated after trial by various combinations of explosives in the base, and fuze and connecting tube.

Captain Prehn proposes another method. His idea is with shrapnel having a base charge to leave out about two layers of bullets under the fuze, and fill the space thus obtained with an explosive. The balls will thus be acted on by two charges. The exterior walls of the projectile will be broken up and the actual part of the shrapnel will send out fragments with great energy and sufficiently thick in distribution. Such a projectile would have the same merits that are ascribed to the bursting shell, and would surpass it when used from a large caliber gun with small velocity. Captain Prehn desires that in the trial of such projectiles, explosives of varying strength be tested, and that the trial should not begin at once with the most violent. The chamber should be charged first with ordinary nitro-glycerine in small proportions, and it should be seen if this bursts the base when set off by a large charge of powder underneath the fuze. Further tests should be made with stronger explosives in the base chamber, still keeping the upper powder charge.

General Rohne thinks this method would be successful, and that an angle of the cone of dispersion from 60° to 70° would be obtained. He believes an adequate effectiveness with the shrapnel can only be had with a large opening of the cone, and that the construction of the projectile is as important as the curvature of the trajectory.

As we have already stated in this paper, Russia has adopted shell with a strong bursting charge as well as shrapnel for its mortars, and France has the *obus allongée* with 6 kg. (13.2 lbs.) of melinite. We have also pointed out that shrapnel from curved fire guns can only be used against living targets behind cover, and is not adapted for destroying blindages or driving out the men from beneath them. Shell with 6 kg. (13.2 lbs.) of ordinary powder can not with certainty destroy such cover, or only by the expenditure of a great deal of ammunition. On account of the limited number of projectiles, however, which the howitzer can take with it, it is to be important that each shot be as powerful as possible.

Though the shell breaks up its wall into a great number of fragments, yet these are very small and not of good shape for overcoming the resistance of the air. The large part of them when the percussion fuze is used will remain imbedded in the ground. The range of the fragments that are not thus imbedded

will be short and they will have little penetration. Nevertheless the moral effect of this projectile will be enormous, as it develops an enormous concussion in the air, which will cause serious injury to internal organs (as the hearing). The projectile likewise has a mining effect in the earth and against overhead cover. The concussion of the air from the French 12-cm. shell will overthrow a thin wall. These shell are also better fitted to demolish thick walls than the field gun shell whose charge is much smaller.

Of course it is necessary with so large a charge that precautions be taken against a premature discharge in the bore. If however the same mass is taken as in the shell of the field gun (which has had as yet no shell bursting in the bore), it will be entirely safe, or at least as safe as human foresight can provide. It is to be remembered here that the pressure on the projectile upon starting in the bore is far greater for the field gun than for the howitzer, whose powder charge is less.

The proportion of shrapnel to high explosive shell which should be carried with the howitzers could only be determined after exhaustive firing tests; very likely the shrapnel will remain the chief projectile.

General Rohne looks upon the use of shell with thin walls and large interior charge as desperate means, and thinks it significant that no other state has adopted it. This must be conceded; yet in the event of war, we will have to count on the employment of like means both on our eastern and western frontier: on the former there will be a devastation of whole tracts of country, and on the latter there will be the *obus allongés*. On no side therefore could we be blamed if to save our skin we grasped at similar means as that here proposed in the shell with a large charge of explosives.

The use of these shell with the tims fuze is excluded for reasons that already have been given.

The service of the howitzer will be simplified if there are not many field gun charges about, for the fewer of these the less likelihood of getting them mixed up with the howitzer cartridges.

As the howitzer must be prepared to attack covered targets at all ranges, a large angle of fall is necessary and one service charge will not be sufficient; for if this is made large it will fail for short distances with the maximum elevation of 40°, and if the charge is made small, the range will be too limited. In the latter case, the final velocity of the projectile would also be too

much reduced; this is important with shrapnel to give penetrating power and proper dispersion to the bullets; the stability of the axis of rotation would also be endangered.

The use of two sizes of powder charges makes a confusion liable, and embarrasses the service of the piece by the necessity for two sets of graduations on the sight. With two charges, the larger would be used for long ranges and for a flat trajectory, the smaller would be used to obtain a large angle of fall up to medium ranges. The limit for the weight of the larger charge would in this case be set by the size of the angle of fall required for concealed targets and by the durability of the piece.

For ranges at which this largest charge fails to give the angle of fall, a smaller charge must be abopted, and eventually a still smaller one when the angle of fall again becomes too small. This is now generally the case; hence with field howitzers we find three different charges. This can be arranged for by graduating the back of the elevation bar for the principal charge, its left side for the mean, and its right side for the smallest. With three charges, the sizes of the two small ones can be so chosen that together they equal the largest charge. In this way it would not be necessary to carry as many cartridges of different sizes, as it otherwise would be if a limber holds 16 rounds, it would need to carry but 16 small and 16 mean sized cartridges to be ready for every demand. Thus if it were required to cannonade concealed targets with an angle of fall of 15°, this could be done with the smallest charge from 1000 m. upwards, with the mean charge from 2100 m. to 4000 meters, and with the first two charges together from 3300 meters up to the maximum range.

H. ORGANIZATION OF THE CURVED FIRE BATTERIES.

There is a difference in practice among the larger European nations in the number of guns assigned to the battery to make the fighting unit. Six is the rule; only Russia and Austria have eight guns to a battery. According to the prevailing views among ourselves, the number of guns should be so chosen that when firing by piece under ordinary conditions and observing the shots, the firing should be continued without pause, and no gun should be kept loaded and aimed waiting for its turn to fire. Hitherto six guns to a battery have fulfilled both of these conditions; and this number has also permitted a more rapid service as the carriage and ammunition have been improved, when occasion has arisen for a maximum effect in the shortest time. But such has been the progress in the way of rapid fire in the last ten years

that with the new field gun, if advantage is taken of this improvement, it may be that the number of guns to a battery could with advantage be less than six.

In this paper we at first treated the howitzer as of a slower rate of fire than the field gun; under section "F" (choice of carriage), we mentioned how a faster rate of fire had been made possible by Krupp's rapid-loading carriage.

Using this carriage and the lighter ammunition with a metallic case, it is difficult to say, in the absence of trial, how many observed shots could be fired by a battery without pauses in the firing, or without one gun being kept waiting on another. In any case the views held at present as to the number of guns to a battery would not be changed. The number might indeed be reduced from six to four, yet again the longer time of flight of the projectile in curved fire might keep the number at six. We shall here consider six pieces to a howitzer battery.

With the number of guns, the amount of ammunition to be taken with the guns is increased, if the battery is to carry with it enough for an engagement of several hours. The drill regulations estimate under ordinary conditions four rounds a minute, on the average, for the battery. Assuming that the howitzer battery, with the rapid-loading carriage can fire three rounds per minute per battery, then 130 rounds must be carried along for each gun, if the battery is to have with it enough ammunition for an engagement that lasts four and a half hours. If the howitzer battery can deliver four rounds per minute, the time of action would be reduced to three and a quarter hours.

As provision must be made for transporting the necessary ammunition, the number of caissons belonging to a battery will depend upon the number of guns. Yet the number of caissons cannot be increased beyond a certain limit, without impairing the mobility and discipline on the march of the long columns that result, which are under the direction of but a single officer. The handling of so many wagons becomes difficult and a good deal will depend on the energy of subordinates. In the order in the field, the second line for the batteries marches in sections immediately behind the artillery units, and under the command of an officer; only in the advance guard does this reserve march in rear. In the former case it is followed by other troops, and if the supply column was too long the troops behind it would come into action too late. This might prove a very serious matter.

Strategy therefore insists rightly that the columns shall be short when they accompany the fighting troops. But since the

caissons must be able to follow the guns everywhere, they must not be more heavily loaded than the guns. From these two conditions upon the number and weight of the caissons, it follows that the amount of ammunition that the battery takes with it, cannot exceed a certain limit. This determines the number of rounds carried for each gun, though this may also be influenced by the manner in which the gun is to be employed. If it is to be used all through the engagement, it will have a larger number of rounds with it than if it is intended to participate merely at certain periods.

It has been taken for granted that the field howitzer will serve not only to cannonade concealed targets, but will also engage in the artillery duel. For this purpose, it must be amply supplied with ammunition.

Allowing for each piece 130 rounds weighing 16.4 kg. (36 lbs.) each, this ammunition might be carried in the following way. In the limber of the piece and of the caisson, 20 rounds apiece; this gives a weight of 328 kg. (720 lbs.) for each limber. The limber of the present field gun carries 30 projectiles weighing 7.5 kg. each or 225 kg. (496 lbs.) in all, together with 30 cartridges weighing 0.64 kg. each, or 19.2 kg. (42 lbs.) in all; this makes a load of 244 kg. (538 lbs.) for the limber. Hence the limber of the howitzer would have a load of 84 kg. (185 lbs.) more than that of the field. This excess would be lessened through the fact that the projectiles are no longer carried in heavy cases, but in wooden boxes. Krupp put 16 rounds in the limber of his field howitzer. This made the total weight of the howitzer 135 kg. (298 lbs.) less than the weight of the present field gun. If four rounds more had been added, the weight of the howitzer would still have been about 65 kg. (143 lbs.) less than the weight of the field gun.

It is true difficulties might be met with in packing twenty rounds in the limber. Since the breadth of the carriage of the howitzer cannot exceed the customary breadth of vehicles, there is available a space of but 125 cm. (49 inches). Ten projectiles side by side take up 120 cm. (47 inches); but the sides of the limber chest and the wooden boxes of the projectiles require more space than five centimeters (2 inches), so that not more than 16 projectiles could be stowed in two rows one above the other. If the four still remaining to make up the twenty could not be carried in compartments on the sides of the limber, *they* would have to be carried in the body of the caisson.

With 130 rounds for each piece, there will be 780 for the battery.

A caisson can hardly carry more than from 60 to 66 rounds weighing 16.4 kg. each. Of these 16 to 20 rounds must be transported by the limber with 40 to 46 in the body of the caisson. The distribution would then be as follows: Gun and caisson limbers with 20 rounds apiece, 340 in all, or if 16 rounds are in each limber 272 rounds in all; in the body of the 11 caissons 40 rounds each (or 46), making 440 (or 506) in all. In the first case there would be 780 rounds with the battery, in the second 778 rounds. The weight of projectiles in the body of the caissons would then be 656 kg. (or 754 kg.). If this should load the caisson too heavily the number of caissons to the battery must be increased from 11 to 12. As the number of howitzers is after all not large, this additional caisson would not increase much the length of the column on the march.

The wagons with a howitzer battery would accordingly consist of 11 (or 12) caissons, 2 wagons with stores, 1 wagon with rations, 1 field forge and 1 forage wagon. There would thus be 2 (or 3) more six horse vehicles than in a battery of field guns at present. It is a question whether one store wagon and the field forge might not be dispensed with.

In men and horses, the composition of the howitzer battery should resemble the field battery. With the small number of batteries that are likely to be present in an army corps district, the howitzer batteries could help out the gun batteries in the maneuvers when the latter were able to bring only four pieces with teams. To have ready for mobilization the requsite number of instructed and experienced men and officers, the howitzer batteries must in peace have their full quota of horses. Until the howitzer batteries have a reserve to supply the losses in war, it will also be necessary that a part of the personnel of the field gun batteries shall be instructed in the service of the howitzers.

Both shrapnel and high explosive shell must be carried in the limbers and caissons, the latter to destroy walls and overhead cover, the former to attack men in the open and behind parapets without overhead cover.

Connected with the tactical questions of the number and combination of the howitzer batteries, there is also the question of the number of the ammunition columns. One column for two batteries would be sufficient. If the wagons of this column were loaded like the caissons of the battery, 25 of them and one spare carriage would serve to transport 1500 rounds, or nearly twice as much as is carried by two batteries.

Opinions differ widely as to the number of howitzer batteries

required, as well as to the mode of their assignment to the tactical units.

In volume 90 of "*Jahrbüchern für die duetsche Armee und Marine,*" it was said that seven divisions (*Abteilungen*) of field artillery should consist of two flat trajectory batteries and one curved fire battery in order that the latter might furnish the means to break through what overhead cover there might be in the intrenchments of the enemy in that portion of their line which the artillery division was set to bombard. It was also held that heavy and light artillery should not be combined in action except in siege warfare, since even the lighter guns of the siege artillery weigh at least 800 pounds more than the field gun. and hence lack efficient mobility.

We agree with this last opinion, but not with the first. In this discussion, we must take into account the new field gun that we are looking for. While a 12cm. (4.7 inches) field howitzer would probably weigh about the same as the present field gun, there are grounds for thinking that the new field gun will weigh less. due to improvements in treatment of the metal. If the gun and howitzer batteries are of different weights (and it would be a matter of several hundred pounds), then in rapid movements over long distances the heavier howitzers would be left behind be arriving late at a position. This would be a serious defect. if meanwhile the other two batteries had to engage with three field gun batteries of the enemy. But even if the three batteries took up their position simultaneously, the howitzer batteries would be slower in opening fire, nor would the three batteries be a match for three field-gun batteries. The officer commanding an artillery division (*Abteilungs Kommandeur*) could thus count on his howitzer battery but to a limited extent in the artillery duel that opens engagements and battles. The control of the firing would, moreover, be complicated, if not impossible, and this would still further increase the inferiority to three field gun batteries of the enemy. By forming the artillery division as thus proposed, the main object of howitzer batteries, the bombardment of concealed targets. is lost sight of ; the howitzers become merely a less effective field gun, and waste on less important targets the costly ammunition designed for concealed targets. If they were afterwards employed for their true purpose they might find their ammunition exhausted or their cannoneers so reduced in number by losses as to be unable to serve the pieces properly. We have in this paper spoken of the howitzers as taking part in the artillery duel, but only in an exigency would they take part from the

opening, otherwise they would be only employed to terminate favorably this duel, when still in doubt, but they would not be used in immediate conjunction with field gun batteries. For the reasons given above, we think the proposition of the "*Jahrbüchern*", to join one howitzer battery to two field gun batteries to form a unit, is not at all to be entertained.

Another plan is to attach a few howitzer batteries to the headquarters of an army, that they may be used at the critical points in the battle. In peace the batteries would be combined in a number of regiments, instructed separately from the other field artillery, and in war they would be assigned to the armies in divisions of three batteries each or in regiments of two divisions each.

But this organization seems open to grave objections. In the battles of the future, great armies will be engaged on each side, and at just that point where the strategy has planned to achieve a decisive success, the stubbornest resistance may be encountered. The concentration of howitzer batteries here may be entirely without consequence. At other points it may be that partial successes are won which, if supported early by a small number of howitzer batteries, might decide the day.

With the great extension of the battlefield, it will be difficult to collect the howitzer batteries from the outstart at the right spot, or to bring them up to this spot at the critical moment. It would be better to distribute a small number of the batteries to the larger units, as the Army Corps, to be employed by them, either on their own line or on that of an adjacent Corps. Unless there are imperative grounds for staking all at a point where the strongest and most tenacious resistance is met, it would be more reasonable to take advantage of small successes that may be gained along the line, to put in reinforcements at such points, and endeavor to turn the success to account. The possibility of doing this seems greater if each Corps has with it howitzer batteries.

With the howitzer batteries thus distributed, the attack will be able to cannonade at all points the overhead cover of the defense, which in a prepared position will be found not at one point, but at several widely distributed along the line. It will at the same time be an easy matter to reinforce the howitzer batteries of one Corps by those of an adjacent Corps.

Whether a division of two or three howitzer batteries is assigned to an army corps would depend upon the results of exhaustive tests, using targets protected against an angle of fall of 22° to 35°. Probably two batteries would suffice.

J. THE EMPLOYMENT OF THE CURVED FIRE BATTERIES.

The employment of field howitzers batteries falls under two heads: (a) their employment on the offensive; (b) their employment on the defensive.

(a) Employment on the offensive.

The field gun remains, as before, the principal fighting artillery of the field; the howitzers reinforce them in attacking concealed targets. We have here to do chiefly with the use of these two species of cannon against shelter trenches and against field howitzers and mortars of the enemy that are protected against the fire of the field guns. The shelter trenches will be thrown up at various points along the line and overhead cover will be constructed in them here and there. Just where this cover is to be found, will not as a rule, be revealed until the battle is on. The engagement will probably proceed as follows: the field gun batteries of both sides will, first of all, fight out the artillery duel; if this has a favorable issue for the offensive, a part of the field guns will be directed against the infantry of the defense, while the rest continue to hold the enemy's artillery in check. If intrenchments are now discovered, the field guns will use shell with the time fuse against them. The shells of the field guns are thus to be used against intrenchments, as well as against substantial targets, like the houses of cities and villages

The field howitzer batteries will be first brought up, where the field guns prove inadequate or fail altogether on account of overhead cover. As each army corps will have a division (Abteiling) of howitzer batteries; several such batteries can be concentrated at points where successes have been achieved and where a heavy fire is needful to carry through a decisive attack.

If however, at a portion of the line the artillery of the attack has failed to reduce that of the defence, the howitzer batteries also could be put into the artillery duel, for in such cases from a tactical standpoint the enemy's artillery would still be the most important target.

In general, the artillery divisions will not take part at the beginning of an engagement, but will be reserved for a later period.

The place of the field howitzer batteries in the columns of march follows from the preceding considerations. The field gun batteries should be placed, as hitherto, toward the head of the column, in accordance with the fundamental principle, to open the fight promptly with a superior artillery. The howitzer batteries should march towards the rear of the column, though not the very last. Some infantry should follow them so as to protect

them from a sudden attack on the flank. If an army corps was advancing on two roads, one division might march on one road with the corps artillery and the other division on the second road with the howitzer batteries.

In what manner shall the howitzer batteries go into action?

If the terrain permits, the howitzer batteries should as much as possible unlimber out of sight of the enemy. The chief reason for this is the longer time, compared with the field gun, between unlimbering and opening fire, together with the howitzer's slower rate of fire. The howitzer batteries if not behind cover, would not be a match for the field guns; the positions they seek will, therefore, not as a rule be the same as those taken by the field guns. Besides, the howitzer batteries with each corps will be few in number, and will be too valuable to be needlessly exposed. By seeking cover they will not only be screened from view, but will be protected against shrapnel from field guns, while for their own part, their fire is just as effective as though they operated in the open. Suitable cover could be found in nearly every kind of country; for this purpose they could take advantage of well defined hollows, the fold of the ground at the foot of a range of hills, woods, villages, farm yards, sand-pits, and also of objects that protect only from view, as fields of Indian corn and the like. The howitzer batteries could also take up a second line behind the field guns, and make use of the range determined by the latter, after adding the distance between the lines. Using smokeless powder with their high angle fire, the howitzers would be very difficult objects for the enemy to locate. As the field guns can reduce their interval to ten paces, for the same reason the howitzers could still more reduce their normal interval, when by this means all the pieces could be brought behind cover.

From such positions the howitzers, if called upon, could assist in the artillery duel without fear of suffering too great losses. But their chief object will be to break up overhead cover by shell fire along the enemy's line of defence, to drive the men out of such shelter and then to make the trenches untenable by shrapnel fire; by collecting the howitzer divisions from several corps, they could be used to bring an overwhelming fire on the intrenchments and points of support of that portion of the line where the decisive attack is to be made. Supported by this howitzer fire as well as by that of the field guns cannonading the men exposed, the infantry of the attack would advance to the closest range, and then make the final rush, while the howitzer

batteries increasing their elevation prevent reserves coming forward to reinforce the line of defense.

Another function of the howitzer batteries will be to assist the infantry in the attack of villages having massive houses, against which the field guns are insufficient.

The howitzer and mortar batteries of the enemy firing from cover must also be attacked, yet this task is secondary to the one already outlined. The location of the curved fire batteries of the enemy might be detected by cavalry scouting on the flank or by means of captive balloons.

This does not yet exhaust all the duties that will fall to the howitzer batteries.

When an army is confronted with the problem of reducing an enemy's frontier forts that block its advance, the howitzer batteries will be of great value. In the vicinity of the fort, which will be territory thoroughly known to the defense, they will have the advantage of operating under cover, and they will be better able than the field guns, to reach the interior of the fort, and to drive off the men close to the ramparts.

Likewise when one or more army corps lay siege to a fortress, the howitzers will have more effect on the fortifications than the field guns. In both these cases the howitzers are effective supports to the advance of the infantry, and prepare the way for the siege artillery which will be brought up to carry through the artillery contest.

(b) Employment on the defensive.

As already stated a great number of states have adopted the curved fire guns. Whether Germany stands on the defensive or assumes the offensive, in either case it will have to reckon upon its probable enemy possessing such batteries. It cannot be disputed that the presence of curved fire guns will be advantageous for the defense, although the only concealed targests in this case are the curved fire batteries of the offensive. The direct fire of the field guns will be more efficient on the defence as the targets are mainly open and the howitzer batteries would have to engage in the artillery duel, as the defense would usually be inferior in number of guns.

When the infantry are advancing to the attack, and the field guns of the offensive leave off firing for fear of hitting their own men, the howitzer batteries of the defense can assist with shrapnel fire in repelling the assault.

What we have said respecting the use of curved fire batteries

on the offensive against similar batteries of the defense likewise holds good for such batteries on the defense.

CONCLUSION.

From all that precedes it will be seen that there is a wide field of usefulness for howitzer batteries, though their use is more limited than that of the field gun. Above all, they are more effective in cannonading concealed targets, and even in their other applications that have been brought out in this paper, their use is in line with that maxim, so true in war, "Time is Money."

It is true that no tests of howitzers have been published which make it certain that these cannon, in their effect against targets protected against 22° to 35°, are the equal of several field guns firing at the same target. It is very probable, however, that they are. It might still be necessary to increase the power of the single projectile for curved fire, after exhaustive trials with various projectiles, in case such trials have not already been carried out. The first condition for the effective cannonading of well protected targets is found in the howitzer, in its sharply curved tragectory.

[Translated by Second Lieutenant GEORGE BLAKELY, 2nd Artillery].

PROFESSIONAL NOTES.

ARTILLERY MATERIAL.

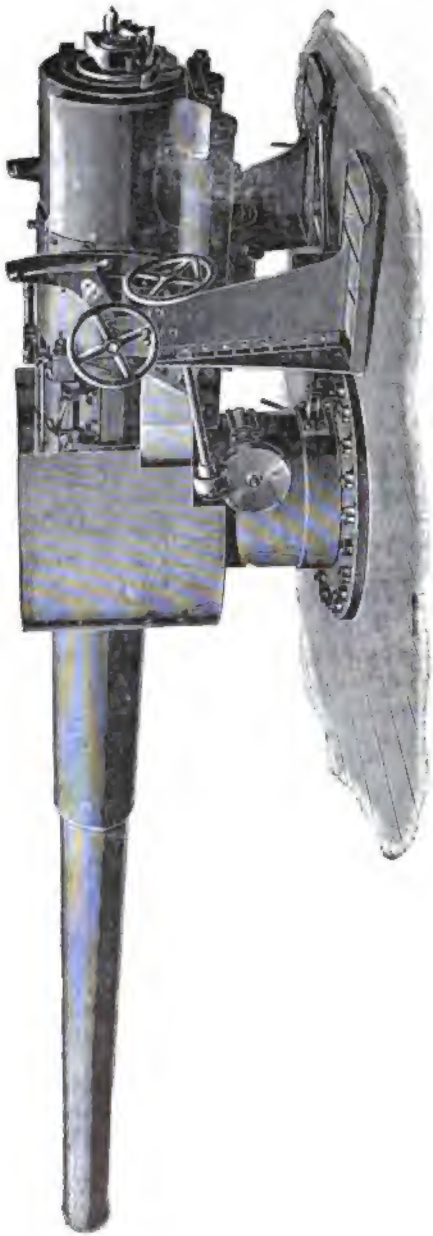


FIG. 1.

a. Guns and Carriages.

Vickers' Guns.

Messrs. Vickers, Sons, and Maxim, Limited, manufacture every type of ordnance, their plant, as we have shown in our preceding volume (lxiv., pages 760 and 791), being capable of dealing with guns of over 100 tons weight, but the demands of the artillerist are now confined within the limits marked by the 50-ton gun, hurling an 850-lb. projectile from the muzzle with a velocity of 2750 ft. per second, and the automatic gun firing as many as 800 shots per minute. All the intermediate types of guns need not be dealt with; the more prominent examples will suffice, but the dimensions and ballistics of all are shown in the table on the opposite page. The large breech-loaders for use in battleships include 12-in., 10-in., and 9.2-in caliber guns, while the quick firers are 8-in., 6-in., 4.7-in., 4-in., and 3-in. weapons, with many Maxim and machine guns. The method of constructing most of the larger guns is known generally as the steel and wire-wound system.

An interesting feature of all the guns is the breech plug, originally invented by a Swedish engineer (Mr. Axel Welin). It is made in segmental portions in steps of varying radii, as will be readily seen from Fig. 2. By this arrangement a plug divided, say, into eight segments, would have six segments or

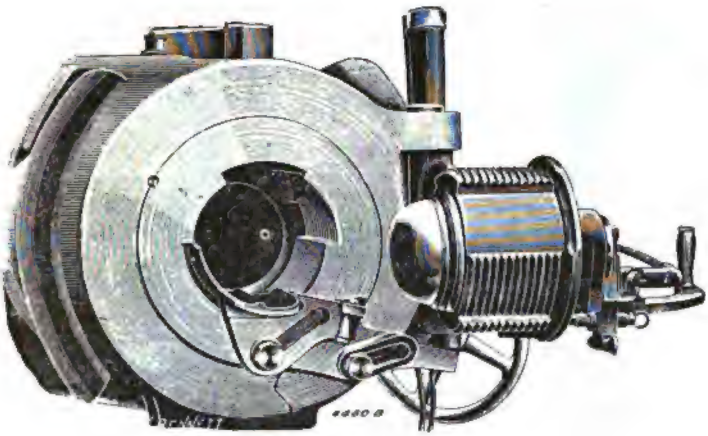


FIG. 2.

three-quarters of its circumference threaded for meeting the strains on the breech; while the ordinary parallel breech plug, with thread and plane surface alternating, has only half its circumference threaded, the other half being useless for resisting the back pressure in firing. This enables the plug to be shortened by one-third of its length, and proportionately lessens the weight. The reduction is of great importance, as the gun is shortened at its heaviest part, which means considerable reduction in its weight. The breech plug, too, can be more easily swung clear of the breech after unlocking, without any curvature, and without the usual longitudinal withdrawal. This can even be done with the De Bange obturator.

The breech mechanism for the 12-in., 10-in., and 9.2-in. guns, is fitted with the necessary gear to enable it to be worked by hydraulic or other power; it is applicable to any gun of smaller or larger caliber, and is suitable for either a right or left-hand gun. The mechanism is so arranged that by turning the handwheel the breech plug, is first rotated and unlocked, then drawn longitudinally to the rear until the obturating pad is clear of its seat and finally swung out of the breech of the gun. The horizontal sliding bar mounted in the carrier has one end connected by a roller stud to the arm which is fixed to the hinge bolt of the carrier. On the top of the sliding-bar are formed teeth into which is geared a pinion, pivoted in the recess in the carrier. This pinion is keyed to the shaft on which is fixed the actuating lever. Projecting from the actuating lever is the roller stud which works in a slot in the rear face of the breech plug to rotate it. On the stem of the carrier, on which the breech plug is carried, there is fitted, with freedom to turn, the sleeve with a forked arm projecting from it. On the outer circumference of the sleeve are three inclined grooves of increasing pitch. Three roller studs, mounted on a ring fitted into the bore of the breech plug, work in the inclined grooves of the sleeve in such a manner that a longitudinal movement is given to the breech plug, when the sleeve is turned by a roller stud, which projects inwardly from the face of the horizontal sliding bar, and works in the forked arm of the sleeve. A worm and wormwheel operated by a handwheel are carried in a suitable position at the breech of the gun, and when rotated, cause the movement of the actuating arm.

To open the breech the handwheel is rotated, and thus, by means of the

wormwheel, the actuating arm is moved, causing the sliding bar to move horizontally. This revolves the pinion and the actuating lever, which in turn

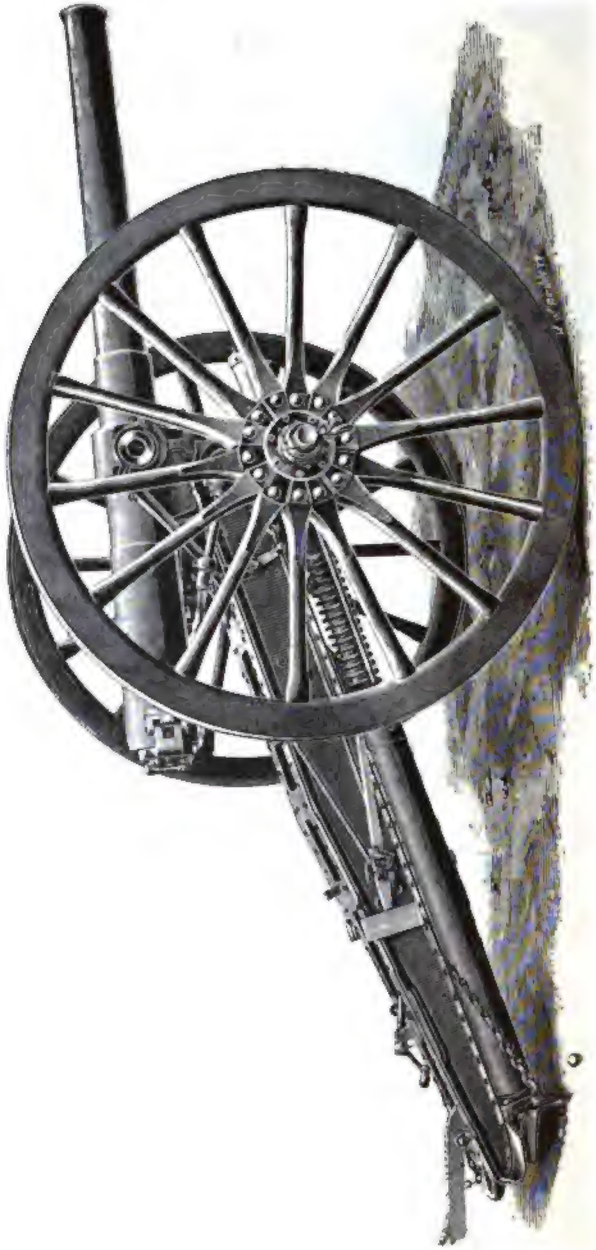


Fig 3

rotates the breech plug at first slowly, and then more rapidly, until it becomes unlocked. The sleeve, which is held in position until the plug becomes

unlocked, by means of a projecting pin working in a groove in the face of the sliding bar, is now free to turn, and by continuing to move the sliding bar the projecting roller stud engages the forked arm of the sleeve and so turns it. The rotation of the sleeve causes the plug to move longitudinally rearwards by means of the projecting studs working in the inclined grooves of the sleeve. After the plug is drawn longitudinally rearwards the continued movement of the actuating arm swings the mechanism out of the breech of the gun.

The gun is arranged for firing by electric or percussion tubes. and its action is similar to that of our 6-in. quick-firing gun. Provision is made so that the mechanism can be worked by hydraulic gear. Suitable clutches are provided, so that the change from hand to hydraulic gear, or *vice versa*, can be easily and rapidly effected by the rotation of a small handwheel.

With a charge of 207 lb. of cordite, and using 850 lb. shot, a muzzle velocity of 2750 ft. per second, and a muzzle energy of 44,573 foot-tons can be obtained with this very serviceable 12-in. 50-ton gun, for which Messrs. Vickers, Sons, and Maxim, Limited, have an admirable type of mounting for use within barbettes, whereby the gun can be rapidly worked in action, giving considerable rapidity of fire, without introducing any delicate or complicated mechism.

The 8-in. and 6-in. quick-firing obturating gun of 45 calibers, (Figs. 1 and 2), are equally remarkable in respect of the simplicity of their mechanism and the high energy developed. The guns are of steel and wire construction; and the total length from the breech face to the muzzle is 31 ft. in the case of the 8-in., 23 ft. 3 in. in the 6-in. weapon. The 8-in. gun with a charge of 52 lb. of cordite, and using 210-lb. projectile, attains a muzzle velocity of 2750 ft. per second, and a muzzle energy of 11,012 foot-tons. With 25 lb. of cordite for a charge, and using 100-lb. shot, a muzzle velocity of 2775 ft. per second and a muzzle energy of 5340 foot-tons has been obtained with the 6-ih. gun. The breech mechanism is illustrated in Fig. 5, the view showing the breech open.

The breech plug is opened or closed by the horizontal movement of a hand lever. The same action rotates, locks, or unlocks the plug, swings it in or out of the gun around the pivot on which it is mounted, and causes the percussion and electric striker to make or break contact at the required positions during the working of the mecanism. The arrangement consists of a link, one end of which is so pivoted on a pin projecting from the rear face of the breech plug, that the link works in a plane parallel to the breech face of the gun; while the other end is pivoted to a short crank mounted on the plug carrier, and around the boss of this crank are formed "skew gear" teeth. The hand lever for actuating the breech mechanism is pivoted on the plug carrier, and moves in a plane at right angles to the breech face of the gun. Around the boss of the hand lever is fitted a skew gear wheel, which gears with the skew teeth formed on the boss of the crank.

The whole is arranged and proportioned in such a manner that when the breech is closed, the hand lever lies close up to the breech face of the gun. The arrangements of centers and pivots, together with the relative lengths of the link and crank, provides great power when opening or closing the breech.

On swinging the hand lever away from the gun, so as to open the breech, the crank moves the link past the locking center a short distance, without causing any perceptible movement of the plug. The further movement of the hand lever causes the crank to turn, and by means of the link rotates the plug, at first very slowly (thus obtaining great power), and then more rapidly,

until it beomes unscrewed. The carrier then moves with the lever, swinging the plug clear of the gun.

A loading tray is provided, which is automatically moved across the breech face and raised into the loading position when the breech is being opened, and lowered when it is closing. The firing gear is arranged for firing by electric or percussion tubes, and is operated by the movement of the hand lever and link. It is so arranged that the first movement of the hand lever, when unlocking the breech, acts on the firing gear and makes the gun absolutely safe before the breech plug commences to unscrew. By the continued

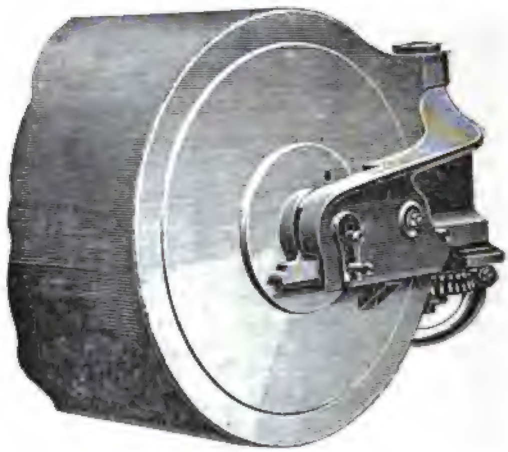
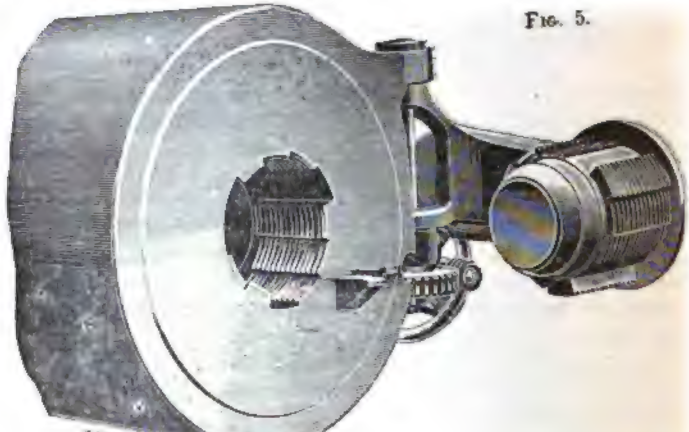


Fig. 4.

Fig. 5.



movement of the link the empty tube or primer is automatically ejected. The form of breech mechanism described, which is a patent of the company, embodies several marked improvements over existing designs. There is a considerable reduction in number of parts. The mechanism is quickly and easily taken to pieces, while the accessibility of the parts is a great feature. The lever which opens and closes the breech by a horizontal movement, occupies a very small horizontal area, so that the mechanism is easily worked in a restricted space. An improved and strengthened form of loading tray has

been introduced, whereby existing difficulties as regards the tilting of the shot are entirely overcome.

The casemate mounting for these two quick-firing guns only differs in slight details. It consists of a steel top carriage resting on balls, running on ball bearings on a steel pivot. The cradle in which the gun slides is a cylinder; attached to the cradle are three cylinders, one to overcome the recoil and the other two (one on each side of the recoil cylinder) contain the springs for running the gun up to the firing position after the recoil. The connection between these three cylinders of the gun is made by arms projecting from the breech ring. The whole weight of the moving parts, gun, cradle, and carriage is taken on the balls above referred to, so that the training is very easy. The elevating and training operations are performed by the rotation of two handwheels conveniently placed with regard to the shoulder-piece against which the gunner leans. These two handwheels are worked on the left side of the mounting, which has also an auxiliary handwheel on the right side, so that, if necessary, two men can conveniently train the gun. The recoil cylinder is of the usual construction, being fitted with a valve key supported at both ends, the valve key being of stronger section than is usual, and the whole arrangement of fewer parts. The shield is of the usual casemate type, the pedestal being very strong, to withstand the impact of small projectiles. This type of mounting affords increased protection from shell fire by the construction of the top carriage, the front of which is of considerable thickness, while the general arrangement of the several parts, such as recoil cylinder, spring cases, elevating and training gear, is well disposed and under exceptional protection. The parts are few in number, easily kept in good repair, very little attention being necessary. The form of cradle is of strong design and completely covers in the breech end of the gun, thus preventing dirt, grit, etc., impairing the working.

The 4.7-in. quick-firing gun is also of 45 calibers, the total length from the breech face to the muzzle being 18 ft. 1 in., and with 9 lb. of cordite for a charge, and using 45-lb. shot, a muzzle velocity of 2600 feet per second, and a muzzle energy of 2109 foot-tons can be obtained. The breech mechanism is similar to that described for the 6-in. quick-firing gun (obturating). Sometimes a metallic case is used in place of a "De Bange" obturator, the firing and safety gear being modified to suit, and no shot tray is required.

The mounting is somewhat similar to the 6-in. quick-firing gun just described, but with this slight difference, that while the cradle in which the gun slides has a similar cylinder to overcome the recoil, there is only one cylinder for running the gun forward after recoil.

Another noteworthy weapon amongst those whose dimensions, etc., are given in the table is the 12-pounder (3-in.) quick-firing naval gun, a favorite weapon amongst the auxiliary armament on all warships. The breech plug and mechanism is similar to that described for the 6-in. quick-firing gun. With 2 lb. 9 oz. of cordite for a charge, and using 12.5 lb. shot, a muzzle velocity of 2700 ft. per second, and a muzzle energy of 632 foot-tons can be obtained. The center-pivot mounting for this 12-pounder is similar to that of the 4.7-in. gun.

The 12-pounder 3-in. quick-firing field gun (see Fig. 3) is 23.5 calibers, and the characteristic feature of the carriage is the method of taking up the recoil. All parts of the carriage are free to recoil except the hydraulic buffer, which is placed between the side cheeks of the trail. The front end of the buffe

piston is attached to the front end of the carriage, and a strong spade is fixed to the rear end of the hydraulic cylinder. The cylinder is further connected to the trail by chains. Around the part of the piston-rod which projects outside the hydraulic cylinder is placed a powerful spring, which is compressed at the same time as the rod is forced into the cylinder. The trail is of special form and length, so as to slide freely back and obviate all "jump." On firing, the spade is forced into the ground, thereby arresting all movement of the cylinder rearwards, but the trail, being free to move to the rear, forces the hydraulic cylinder and springs to assist in taking up the recoil, while the spring serves to run the gun forward into position again.

The gun is connected by trunnions to the top carriage, which is pivoted to the front part of the trail, so that it can be trained through an arc of 8 degrees (*i. e.*, 4 degrees on either side of the axis of the mounting). This permits small adjustments in laying without any movement of the trail. If required, the hydraulic buffer can be removed in about one minute; the mounting may then be used as an ordinary field carriage, and the recoil, which will then be about 7 ft., is checked by means of ordinary shoe brakes applied to the tyres of the wheels. A rate of fire of 12 aimed rounds per minute may be obtained with the use of this mounting. This system affords an efficient method of absorbing the energy of recoil and returning the gun to the firing position without disturbing the laying, and without subjecting the mounting to any excessive strain, combines the advantages of a quick-firing gun with the lightest possible construction of mounting, which is due to the length of recoil and to the mass of the recoil parts. —*Engineering*, May 20, 1898.

b. Armor and Projectiles.

*   *   *   *   *

c. Powder and Explosives.

Smokeless Powder.

Although the war is not many weeks old, it has been waged long enough to impress upon the combatants many important truths which were understood in a vague way before the conflict, but were never appreciated at their full worth until now. We have drawn attention in a previous issue to the lessons of Manila Bay, chief among which is the vital importance of good marksmanship as the decisive factor in a naval fight. The excellent work of our gunners was nothing more than we all expected ; it was in keeping with the traditions of our navy, and in the present war, just as in all those that preceded it, the efficiency of our gun crews is the result of much patient and careful practice at the targets during the ordinary routine of peace maneuvers and cruises.

It is our duty, however, to draw attention to the fact that our ships are laboring under a serious disadvantage in having to use the smoke producing and obsolete brown powder with which they are supplied, instead of the modern smokeless powder, which is in universal use throughout the world. In every engagement which has taken place, not even excluding the Manila fight, eyewitnesses have noted the fact that our ships were speedily enveloped in dense clouds of smoke produced by the fire of their own guns. The smoke in some cases hung like a pall about the ships, completely shutting out the object of attack from our gunners and preventing them from observing the flight of the projectiles. This was the case at times at Manila, it seriously impaired our work at San Juan, and the same trouble occurred in the recent reconnaissance at Santiago. The objections to brown powder were powerfully illustrated in the last named conflict, owing to the fact that one of the

ships, the *New Orleans*, was using the smokeless powder (cordite) which has been adopted in the English navy. She was not at any time shrouded in smoke, and eyewitnesses spoke in glowing terms of the accuracy and rapidity of her fire.

How it comes that our ships, with the one exception mentioned, are supplied with old fashioned powder when powder of a far more efficient type has been in use in other navies for five or six years is a question that we are unable to enter into fully at this time. There has been a reluctance on the part of our authorities to supply the ships with high explosive powder, because of its dangerous character; but of late years improved powder of this class has been carried on foreign warships in all climates and weathers with perfect safety, and the time has surely arrived when we can venture to adopt that form of smokeless powder which our experts have determined to be the best.

The advantages of the smokeless over the old type are many and valuable. The discharge of a brown powder, especially in the larger guns, is accompanied with enormous volumes of dense, opaque smoke, whereas the smokeless powder produces only a faint mist or haze, which is quickly dissipated. The one produces a large amount of residue which fouls the gun, the other produces but little residue and leaves the gun practically clean for the next round. The smokeless powder is far more powerful weight for weight, the charge of brown powder for our 12-inch gun weighing 425 pounds, whereas the charge of cordite for the 12-inch wire gun weighs only 167½ pounds. Smokeless powder burns very slowly, giving off its gases gradually, maintaining a fairly even pressure throughout the whole bore of the gun, thereby enabling a high muzzle velocity to be obtained with a comparatively low maximum pressure in the gun; whereas the brown powder burns more quickly, producing a less uniform pressure throughout the travel of the projectile in the bore. Fifteen tons to the square inch is the limit of pressure which our guns are designed to stand in service. With brown powder this pressure is reached at the instant of firing, the charge is less gradually converted into gas, and as the projectile travels along the bore the pressure rapidly falls, owing to the increased volume of the space behind the shot. With the smokeless powder, a much higher velocity may be obtained without exceeding the normal pressure of fifteen tons. This is due to the fact that the powder burns more slowly, more gas being given off as the shot travels along the bore. The pressure is maintained at a high level up to the time that the projectile leaves the muzzle, and consequently the velocity is proportionately increased. The muzzle velocity of the 6-inch gun on the *Massachusetts*, which uses brown powder, being 2,080 feet per second, whereas the 6-inch gun on the *New Orleans*, using smokeless powder, has a muzzle velocity of 2,642 feet per second.

By the introduction of smokeless powder the muzzle velocity of our guns could be raised from 400 to 500 feet per second without exceeding the safe maximum pressure for which the guns were designed. Increased velocity means a more level trajectory and a greater penetration. When to these advantages are added a smokeless discharge and the ability of the gunner to take note where the projectile strikes, the immense superiority of the smokeless powder is manifest.

Excellent smokeless powders have been produced in comparatively small quantities by our government experts; but the private manufacturers have not as yet turned out successful smokeless powder in large quantities. If they apply themselves to the task in good earnest, they can undoubtedly

equal or surpass the products of European factories. It is to be hoped that a healthy rivalry will spring up in this important industry, and that before long an efficient, stable and thoroughly reliable smokeless powder will be in general and exclusive use in the heavy guns of both our army and navy.

—*Scientific American*, June 11, 1898.

The Maxim-Schüpphaus Smokeless Powder.

In our issue of August 20, 1897, we gave an account of the smokeless powder invented by Mr. Hudson Maxin and Mr. Schüpphaus. It will be remembered that the distinguishing feature of this powder is that it burns slowly at first, when the projectile is moving gently through the bore of the gun, and that its rate of combustion increases steadily as the speed of the shot augments, the object being to keep a fairly uniform pressure behind the projectile all the time it is in the barrel. This result is attained by forming in the

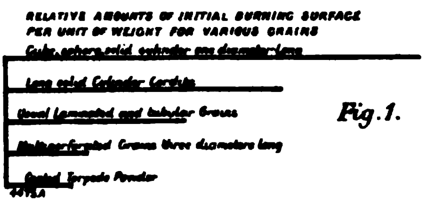


Fig. 1.

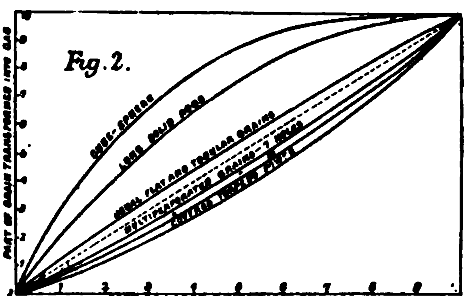


Fig. 2.

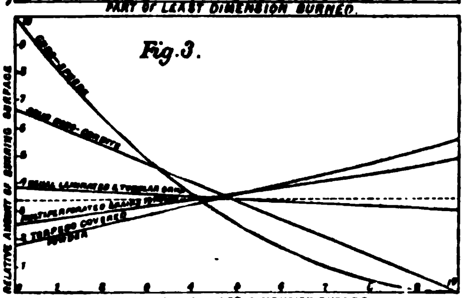
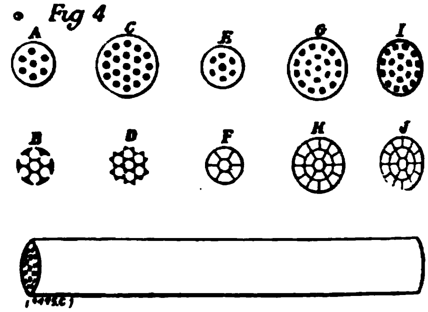


Fig. 3.

Fig 4



powder longitudinal perforations, of polygonal cross-section, and, in some cases, by delaying the ignition of the outer surface of the powder by coating it with varnish. In illustration of the variation in the rate of combustion of powder grains or masses, due to the area exposed to combustion, Mr. Hudson Maxim and Mr. Fred H. McGahie have furnished us with three diagrams. Fig. 1 shows the relative amounts of initial burning surface per unit of weight presented by various grains. The upper line represents cubes, spheres, and solid cylinders one diameter long; the second line represents long solid cylinders, like cordite; the third, multi-perforated grains three diameters long; and the fourth coated torpedo powder of the same kind. Evidently the last two present a relatively small area for combustion at first.

When the diameter of a cube has by combustion been reduced 0.2 of its burning thickness or least dimension, 0.45 of the entire cube has been converted into gas. When by combustion the diameter has been reduced 0.5 of its least dimension, 0.875 of the entire weight has been converted into gas.

This transformation of seven-eighths of the charge into gas when the grain is only burned half through is hardly an ideal way of obtaining high ballistics, especially when the grains are made of such thickness as to be wholly consumed by the time the projectile leaves the gun. The flat, laminated, or tubular forms of grains employed in smokeless powders, although an improvement upon the cube, are still unsatisfactory. With the reduction of the least dimension by two-tenths, there has been transformed into gas 0.22 of the charge, and by the combustion of 0.5 the gas figure is 0.53 of the charge, but still such powder is consumed with a rapidly decreasing burning area.

With the multi-perforated grains of the Maxim-Schüpphaus powder a different result is obtained. With the seven hole segmental grain, when 0.2 of the burning thickness is consumed, only 0.17 of the grain is burned, and upon the consumption through a thickness of 0.5 of the least dimension, but 0.45 of the same is consumed. With the 19 hole segmental grain, when 0.2 is burned, a combustion has taken place of only 0.15 of the entire thickness of the grain, and when 0.5 of the thickness is burned, but 0.42 of the weight of the charge is consumed, and the powder gas is evolved with a constantly increasing rate.

Fig. 2 graphically represents the relation between the proportion of the least dimension burned, and the corresponding portion of the weight of the grain burned. The dotted line represents the combustion of a grain with a constant rate of evolution of gases. The curves above show grains with decreasing rates, and the curves below grains with increased rates. Only the Maxim-Schüpphaus powder gives the lower curves.

Fig. 3 combines the data of Figs. 1 and 2, and illustrates in a still better way the peculiarities of the multi-perforated grains. This figure represents the relative amounts of burning surfaces at different stages in the combustion, such as would be presented by equal charges of a powder made up into the various forms of grains, all having the same burning thickness.

Fig. 4 shows at A, a cross-section of an original Maxim-Schüpphaus grain with seven perforations, and B shows the same grain when the perforations have burnt out so that they become tangent. With such a grain the maximum ballistics are attained when it is made so that the perforations become tangent at the instant before the projectile leaves the gun. But with such a grain 15 per cent. remains unburned, consequently it is necessary that the perforations become tangent and the maximum increase of burning surface attained just before the projectile reaches the muzzle of the gun. In other words, the powder is made quicker.

A material advantage is secured by making the grain larger and perforating with a larger number of holes, preferably 19, as shown in C, Fig. 4. D shows C burned out until the perforations become tangent. Obviously the larger the number of perforations, the higher the ballistic value of cylindrical grains, when the same are made without exterior protection.

Colloidal smokeless powders are burned only by surface combustion, so that the grain may be made with equal burning thicknesses in all directions between angular perforations having parallel surfaces, whereby the entire grain is caused to be completely consumed at the instant of interjunction of the perforations with one another.

E, Fig. 4, shows an end view of a 7 hole grain having angular perforations, and F shows the same grain burned out to a point an instant before the interjunction of the perforations. G is an end view of a 19 hole grain with angular perforations, and H shows the same grain burned out to a point an instant before the interjunction of the perforations. I is an end view of a 19 hole

grain of torpedo powder with angular perforations, with an exterior covering or coating of non-explosive material, and J shows the same grain an instant before complete consumption. It will be observed that there is no exterior combustion, except of the coating, the coating being made of a thickness determined by experiment, so that it shall be burned through at the instant the rest of the grain becomes entiraly consumed. K is a side view of a grain of coated torpedo powder, the same as is shown in cross-section in Figs. I and J.

The Maxim-Schüpphaus powder compound is also a very important part of the system. It is especially adapted to the production of multi-perforated grains. The inventors state that after extended investigation they have discovered a new property of nitro-cellulose by virtue of which their powder compound conforms exactly to the shape of the die, and retains that form without warping or cracking in drying. This formula may be varied with respect to quantity of nitro-glycerine within wide limits, either leaving it out altogether, or employing any percentage that may be desired, so that the powder compouud, or process and composition, may be adapted to fit the ideas of powder experts who have different opinions concerning the advantages and disadvantages of varying percentage of nitro-glycerine.

In an Armstrong 12-centimeter rapid-firing gun, Maxim-Schüpphaus powder gave a velocity of 2037 ft. per second to a 55-lb. projectile, on a pressure of 33,500 lb. Cordite supplied with the gun from England gave a velocity of 2076 ft. per second, on a pressure of 40,000 lb., only 42 ft. more velocity with 6200 lb. greater pressure.

The above results were obtained with a compound containing only 10 per cent. of nitro-glycerine, but notwithstanding this fact, higher velocities for less pressures have been uniformly attained with the Maxim-Schüpphaus powder than with any high percentage nitro glycerine powder that has been fired against it. Of course, still higher results may be obtained with the Maxim-Schüpphaus powder by adding a larger percentage of nitro-glycerine to the compound. It is well known, however, that large percentages of nitro-glycerine enhance the erosive action of the powder gases upon the gun, and that low percentage compounds like the Maxim-Schüpphaus, under equal pressures, have much less such action.

The chief amount of erosion is produced while the projectile is moving along the first few feet of its travel in the gun, due to the greater heat and density of the gases under the excessive pressures necessary to produce high velocities with usual forms of powder grain. When the pressure has, however, fallen to a point where it equals the maximum pressure necessary to produce equivalent velocities with the Maxim-Schüpphaus powder grain, there is no longer any erosion, or practically none. Consequently, with the Maxim-Schüpphaus powder, due to the maintenance of pressure, there is never any necessity of mounting the pressures to a point sufficiently high to erode the gun.

It is not claimed that a simple cylinder of explosive material, having longitudinal circular perforations, as an article of manufacture, is new or patentable; but Messrs. Maxim and Schüpphaus claim that the process and the tools are new, by means of which they produce such a rod or cylinder commercially of the compound or material of which it is essential that the grain should be made. Furthermore, they state that it is impossible to produce multi-perforated rods or grains of powder with the small quantity of solvent employed by them, and which secures the material against excessive shrinking, warping and cracking in drying, except by the employment of the mixed guncottons formula and process patented by them.

Tri-nitrocellulose employed alone, requires a very large quantity of solvent to dissolve it, or even to render it plastic, and it is impossible to dry grains of it of any considerable size without their cracking all to pieces. It is furthermore very difficult to make such a compound take and retain the shape of the forming die.

Consequently, unless a very large percentage of nitro-glycerine is employed, it is impossible to work such a compound successfully into the form of multi-perforated grains for large guns. In order that a powder compound shall take and retain the shape of the die in all its geometrical details, it is essential to employ special tools, special processes, and a special compound, and a compound which will permit of being worked in a much drier state, that is to say, with much less solvent than has heretofore been attempted. By means of their special formula of mixed guncottons compounded together, and by working the powder at a slightly elevated temperature, the gelatine-pyroxilin, acting with a very small quantity of solvent, renders plastic a compound consisting of from 80 to 85 per cent. tri-nitrocellulose, or from 90 to 100 per cent. of mixed guncottons, as any desired percentage of nitro-glycerine may be used, or that material may be dispensed with altogether.

The following under the head of "Form of Grain," is quoted from the report of the Chief of Ordnance, United States Army, 1896, page 197:

"In my last annual report, I stated that the colloidal smokeless powders, unlike the charcoal powders, possess the property of burning by parallel surfaces in the gun. This property is a very important one, and enables the powder-maker to fully realize the theoretical advantages of a progressive combustion of the charge based on the amount of burning surface, long striven for but never obtained with charcoal powders. An example, showing the effect of the form of grain, occurred in my experience during the year. Working with a fixed composition, I endeavored by varying the thickness of a flat grain, about ⅜ in. square, to adapt it to the field gun. The best results obtainable were 32,000 lb. pressure for the standard velocity of 1450 ft. per second. I then had the same material made in the form of a 7 perforated cylindrical grain, and got at the first trial 1450 feet per second with 26,500 lb. pressure. The 'progressiveness' of these forms, as defined in my report in the Report of the Chief of Ordnance for 1896, is about 0.6 and 1.2 respectively.

"From the method of combustion by parallel surfaces and the low velocity of such combustion, it results that at least one of the dimensions of the grain of smokeless powder must be small. If, then, the powder be made in solid grains of a generally cubical or spherical form, they will be so small as to hinder the inflammation of the charge, and so give rise to irregular velocities and abnormal pressures. The most obvious method of obviating this difficulty is to make the powder in the form of rods or strips, which is a very useful form, and very favorable to regular inflammation.

"But then, this form is less progressive than the multi-perforated cylinder; and by increasing the number of perforations a grain of any desired size may be obtained for any given thickness of the walls between the perforations.

"All things considered, the perforated cylinder or disc proposed by General Rodman many years ago, and recently revived in the Maxim-Schüpphaus powder, appears to me to be the most suitable and promising form for the colloidal smokeless powders."

It is obvious that a powder which presents a smaller initial burning area than another, and whose area increases instead of diminishing as combustion progresses, must be subject to enormously less variation in ballistics than a

powder which presents the maximum area to the ignition flame and burns with a constantly diminishing area.

The Maxim-Schüpphaus smokeless powder, when compared with cordite, pound for pound, offers about one-fourth to one-fifth of the initial combustion area, and when compared with ballistite or cubical powders, it offers, pound for pound, less than one-sixth of the initial combustion area. Therefore, it seems probable, when equal charges are fired under like conditions, the Maxim-Schüpphaus powder will give at most not more than between one-fourth and one-fifth the variation in initial pressures that cordite can give. The same holds true for velocities, and the results of firing of this powder substantiate this claim.

In the United States Army 3.2-in. field gun, with a density of loading of .8041, the powder chamber being filled completely with the powder, six shots were fired which gave an extreme variation in muzzle velocity of only 6 ft., and an extreme variation in pressures of only 500 lb., the results being about as nearly identical, in fact, as could be measured with the instruments employed These results were obtained with a grain having only seven perforations; while a grain having 19 perforations and the outer surface coated, as in the torpedo powder, whereby the initial combustion area is materially reduced, must give even less variation.

With the externally protected powder proposed by Mr. Hudson Maxim for throwing high explosives from ordnance, with a pressure of 10,000 lb. to the square inch, it appears rational that the variations in pressures and velocities could, at most, be only one-third of what the same powder would give fired under a pressure of 30,000 lb. Hence, under these conditions, the tendency to variation in pressures and velocities could be only one-fifteenth of the variation given by the usual forms of smokeless powders in high power guns, thus providing against erratic pressures or velocities.

All the advantages that have ever been claimed for compressed air as a means of propulsion for high explosives appear to be secured by the use of the Maxim-Schüpphaus snrface protected powder, while gunpowder has the advantage over compressed air in the enormously increased range attainable by it.

—*Engineering*, June 10, 1898.

d. Torpedoes.

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e. Range and Position Finders.

A New Range-Finder by Zeiss. By Dr. Friederick Wächter.

THEORY AND DESCRIPTION OF THE INSTRUMENT.

In December, 1897, Dr. Czapski, representing the well-known optical instrument maker, Karl Zeiss of Jena, submitted to the Technical Military Committee, with a view of having it tested a new kind of range-finder, an instrument interesting from the mere fact that its construction involves an entirely new principle not heretofore applied to range-finders.

Whereas, all range-finders heretofore adopted or proposed have been based on the trigonometrical solution of a right-angled or oblique-angled triangle, i. e. rested on a purely mathematical foundation in this new instrument of Zeiss, a physiological phenomena, for which, indeed, a mathematical expression can be found, plays the principal part.

This physiological phenomenon lies in the fact that Zeiss's instrument

presents to the left eye of the observer a picture which has certain differences of position, as compared to the picture presented to the right eye at the same time, and these differences apply in a similar way both to the objects and the terrain in the field of view, and to a scale of distances in the instrument itself. Now, when—by the action of the nerves of sight, or the brain—the two pictures of the left eye and the right eye are made to coincide and form a single picture, a steroscopic view of the landscape together with a scale of distances is presented.

The latter does not appear within the instrument in the position in which the cross-hairs of optical instruments usually appear, but the scale of distances appears to be projected into the terrain, in such a way that the origin of the scale lies about 350 m. in front of the instrument and its farther end about 10.000 m. distant.

The scale of distances, therefore, marks the range of the target, and it is only necessary to determine at what point of the scale the object is, in order to obtain its range. Since the reading of the scale, after a little practice, can be effected very rapidly, and is easier in case of movable targets than with fixed targets, this instrument possesses great advantages, aside from the fact that the measurement of distances can be effected from one point and by a single observer, without requiring an assistant, a second line of vision, a turning about of the instrument, or any other processes involving a loss of time.

In order to explain the action of this interesting instrument, it will be necessary to investigate briefly the principle of steroptical vision.

The shaded rectangle *a b c d*, Fig. 1, represents the plan of a house. At a certain distance, *D*, in front of the house is an observer, say at point *I*. At this point he can see only the front, *a b*. and obtains the view despicted in in Fig. 2. If now the observer moves to a second point, far to the right, as at II, he sees both the front, *a b*, and the side *b c* of the house at the same time, and obtains the view depicted in Fig. 3. Now by moving to a point farther to the left, as at *III*, he obtains a view similar to that at *II*, but the side is projected into a narrower space, as shown in Fig. 4.

Finally, if the observer takes up a position so that his left eye is exactly in the prolongation of the side *b c*, at IV, for example, the left eye has the same view as at *I*; i. e, it sees only the front *a b* of the house. With the right eye, on the contrary—since the latter lies a distance to the right equal to the interval between the eyes, or about 65 mm.—he can also see a little of the side *b c*, which in this case presents only a narrow space, as shown in Fig. 5.

It is evident that that this space, presented by the side *b* c, when observed from the same point, would appear much broader if the side were ten or twenty times greater, or, if the right line *b* c in the plan, Fig. 1, were much larger, whereas, on the other hand, the apparent space would be narrower, if *b c*—the depth of the house—were smaller. In like manner, the space referred to would be broader if the observer approached the building along the line *b c IV*, and narrower if he moved away from it along this line, i. e. if he viewed the building from a greater distance.

By proceeding along the line *b c IV*, a point would soon be reached, at which the observer would no longer be able to distinguish the side b c of the house, and this for the reason that the visual angle, under which it appears, had become so small that the eye could no longer distinguish the narrow space. The question then is: what relation exists between the distance *b IV*

of the observer from the object and the depth $b\,c$ of the object, when the possibly of distinguishing this depth (the side $b\,c$ of the building) reaches its limit.

Prof. V. Helmholtz answered this question by means of a simple equation:

$$\frac{1}{\rho} - \frac{1}{r} = \frac{1}{F},$$

in which ρ is the distance $b\,IV$ and r the distance $c\,VI$; $\rho - r$ is, therefore, equal to the depth $b\,c$, Fig. 1. The letter F signifies the ultimate limit of stereoscopic view, or the distance at which an object of even infinite dimensions can no longer be stereoptically seen.

To reproduce here the reasoning by means of which V. Helmholtz deduced the numerical value of F, simple as it is in itself, would take us too far for the limits of this essay. We will content ourselves, therefore, with stating that the value of F was found to be 240 m. With a normal eye, therefore, unaided by any artificial means, it is not possible to obtain sterescopic pictures of objects at greater distances than 240 m.

But, as I pointed out in a former article, the limit F of stereoptical sight has not a fixed and definite value, but may have different values.

In the first place, the value of F varies for different observers, because the distance between the eyes differs in different persons (it varies from 58 to 72 mm.), and in a much greater degree does the clearness of vision differ in different eyes.

Moreover, even for the same observer the value of the limit F of stereoptical sight varies, due to variations in the color of the object. in the light on it, in the contrast between its color and that of the backgronnd, in the degree of transparency of the atmosphere, and in the reflecting power of the limiting surfaces.

In general, however, we will not be far wrong, if for normal eyes and average color and light relations, as they obtain in observations in the open, we assume the value of F to lie between 64 and 111 mm., although the value of 240 m. and even of 470 m., may, under exceptionally favorable circumstances, be reached.

Now, since the so-called limit F of stereoptical sight is dependent on the distance between the eyes and the clearness of vision, it must become greater in value if by any means the distance between the eyes and clearness of vision be artificially inreased. An apparatus for increasing the distance between the eyes was described by V. Helmholtz and designated by him as a *Telestereoscope*. This instrument, Fig. 6, consists of two plane mirrors $s\,s_1$, and two larger mirrors, $S\,S_1$, parallel to the former. With the left eye a_1, the observer looks by double reflection in the direction $s\,S\,n$; with the right eye a_r, in the direction $s_1\,S_1\,n_1$, as is apparent from the diagram. The natural distance between the eyes, $a_1\,a_r$, is therefore increased by means of this instrument in a manner as if the eyes of the observer were not at the points a_1 and a_r, but at S *and* S_1. If, therefore, $SS = 65$ mm., and $a_1\,a_r = 65$ mm., this instrument will enable the observer to see stereoscopically ten times as far as with the naked eye, hence 1110 instead of 111 m., or 2400 m instead of 240 m.

If, in addition to the distance between the eyes, the distinctness of vision be increased—by means of telescopes—a further increase of the range of stereoptical sight is possible. This is accomplished in the range-finder of Zeiss, Fig. 7. Besides the reflecting mirrors S and s, which in this instrument

are the surfaces of prisms, there are two telescopes, F and F_1, arranged in a manner similar to those in the well-known Zeiss *relief telescopes*, but of larger dimensions.

In the only sample of range-finder submitted to the Military Committed for the purpose of being tested, the distance SS_1 in Fig. 7 was 87cm. The latter is therefore $879 \div 62 = 13.5$ times as great as the natural distance. The two telescopes ot the instrument, however, possess a power of definition—in case of a magnifying power of 16½ times—of 6 angular seconds, while under similar circumstances the normal, unaided eye possesses a power of definition of about 60 angular seconds, hence, a ten times less destinct vision.

With this instrument, therefore, an observer can see sterescopically $13.5 \times 10 = 135$ times as far as with the bare eye; hence, to a distance of 9 to 32 km. according to the light and color relations of the terrain, and the diaphaneity of the atmosphere.

But the question arises: how is this increased range of stereoptical vision utilized to measure distances?

This may be done in two ways; and the Zeiss sompany furnishes two types corresponding to these two methods.

In one of these types of instruments, which is designated an *Infantry range-finder*, and is intended for measuring distances up to 3000 m. only, there is for each of the telescopes a scale of distances, Fig. 8, which (with subdivisions of 100 m. each) extends from 0 to 3000 m. These two scales are not, however, exactly similar, the distance between the separate lines of subdivision being somewhat different in the two telescopes. The effect of this is to produce an optical illusion, by which the scale appears to extend out into the landscape, and over the objects whose range is to be measured and, as already stated, it is merely necessary to determine which subdivision is over the designated object.

The geometrical and physicial explanation of this apparent projection of the scale of the instrument into the landscape is evident from Figs. 9 and 10.

If we consider the two appearances of the house as seen from the positions *II* and *III* in Fig. 1, in other words Figs. 3 and 4, combined in an ordinary stereoptical double picture, Fig. 9, the following facts are evident: the distances between the edges ad and a_1d_1 of the house on the two pictures is just as great as the distance between the other two edges of the house, bc and b_1c_1, because the two front edges of the house are nearly the same distance from the observer. But, the distance between the edge of $c\,f$ and $c_1\,f_1$ is smaller than the distance $b\,b_1$, because the edge $c\,f$ is farther from the observer than the edge $b\,e$. The distance between the two pictures k and k_1 of the little church is still smaller, because the church stands much farther back than the edge of the house $c\,f$. The pictures of the lamp-post, $l\,l_1$, on the other hand have a distance preceptibly greater than $b\,b_1$, because this lamp-post is well in the foreground.

In general, then, in a stereoptical double picture, distant objects have a smaller—nearer objects a greater distance between them—the more distant objects appear compressed, the nearer objects drawn apart.

If now, on the double steroptical picture in 9, we place a glass plate $m\ n\ o\ p$, Fig. 10, on which the comma-like marks, I II_a II_b III IV, are made in ink, and then look at this plate together with the picture in Fig. 9, through a steroptical apparatus, the mark I will appear at the same distance from the observer as the lamp-post l, the marks II_a II_b will be as far back as the front of the

house *ad be*, mark *III* as far back as the rear of the house *ef*, and finally mark *IV* will appear to be as far back as the little church *k*.

This optical illusion—effected by the stereoscope—results from the fact that the distance between the marks *I* and I_1 is equal to that of $l\, l_1$, the distance $II\, II_1 = b\, b_1$ and the distance $IV\, IV_1 = k\, k_1$.

For the same reason, the target *t* (or t_1), Fig. 8, which is, say 950 m. distant, appears between the scale marks 9 and 1, that is between the subdivision lines 900 and 1000, from which we infer at once that this target has a range lying between 900 and 1000 m., and we can also estimate by the eye whether this point is nearer 900 or 1000, and how much.

The scale of ranges represented in Fig. 8, has, therefore, certain advantages, but also some disadvantages; for example, in the larger instrument, when the range of measurement extends from 350 to 10,000 m., we obtain the entire field of view full of scale subdivisions and figures, whereby observation is interfered with; and again a first false reading is easily repeated in subsequent readings and it is very difficult to get rid of this first impression and obtain correct readings.

Hence, in the larger instrument, the scale is so arranged that only a single scale subdivision appears in the field of view. This scale line, by means of a screw, can be changed from an initial distance of 350 m. to infinity. This is effected in the construction of the instrument, by giving the scale notch a fixed position in each tube, and then by means of the screw referred to above, causing a change of position of the right-hand picture relatively to the left-hand. This lateral change in the picture presented is not detected by the eye — in case the two tubes are properly adjusted — but the latter receives the impression that the landscape is standing still and the scale notch moves from or toward the observer.

To actually measure a distance, therefore, it is only necessary to turn the screw until the scale notch stands exactly over the point whose range is to be determined. The exact distance can be read off on a graduated cylinder connected with the screw.

RESULTS OF MEASUREMENT.

It may not be uninteresting to add here a few other data, particularly on the results of some actual measurements carried out with the Zeiss range-finder.

In order to measure at all with the instrument two conditions must be fulfilled. In the first place the left telescope must be adjusted for the left eye, and the right for the right eye, so that objects may be seen with equal definition and clearness through both. Then the distance between the axes of the two telescopes must be made the same as that between the eyes of the observer, to within one millimeter. A special screw is used to accomplish this, which gives the reading of the distance between the limits of 58 and 72 mm. The advantage of this last arrangement is that, by observing the reading when once the telescopes are properly adjusted, the proper adjustment may be made again in a few seconds, in case another observer has used the instrument in the meantime.

Now, aside from the fact that the correct adjustment of the two tubes is an essential condition, without which it is absolutely impossible to obtain even approximate measurements of distances, this correct adjustment of the instrument is not in itself sufficient to enable the observer to make measurements. He must be able by strong will-power to fix the movable scale notch,

(or the entire scale in the smaller instrument) and to concentrate his attention on it, so that the landscape in the field of view of the telescope will not draw his mind from it and thereby lead to error.

This is, apparently, a physical or psychical phenomenon, for which different persons are fitted in very different degrees. Of twelve persons, who undertook to make measurements with the Zeiss range-finder, only eight were enabled to carry out measurements with more or less accuracy, while the other four were not able to do this at all, because, in their case, the range scale appeared constantly at the same distance for all positions, and did not move out into space up to the object as it should.

The author of the present article, who made a considerable number of measurements, found the statement made by the Zeiss Company, that the errors of observation became smaller with practice, confirmed. Still, at great distances, 4000 to 8000 m. the variations were considerable, so that it appeared appropriate to determine the limits of error for instruments of this construction.

The equation of Helmholtz, previously given:

$$\frac{1}{\rho}-\frac{1}{r}=\frac{1}{F}$$

furnishes a simple means of arriving at this determination. In this equation ρ denotes the distance for which the error is to be determined; ρ is therefore, known. $\frac{1}{F}$ is a constant, the numerical value of which need not be known for a general solution. The error of observation to be determined is $\rho - r$. Hence, to find this error of observation, only r has to be determined. If we give ρ the values 1000, 2000, 3000, etc., meters, in order, the errors will generally be found to increase in the ratios $n:n^2:n^3:n^4:n^5$, as the distances increase in the ratios 1:2:3:4:5. As the distances increase in arithmetical ratio the errors of observation increase in geometrical ratios.

By means of this equation, however, it is possible to determine theoretically the error of observation for a particular instrument. The value of $\frac{1}{F}$ may be calculated from the instrument's magnifying power of the natural distance between the eyes, and the natural distinctness of vision, as already explained.

If the instrument magnifies the distance between the eyes 13.5 times, and the distinctness of vision (or *definition*) 10 times, then the value of F for this instrument is $13.5 \times 10 = 135$ times as great as for the unassisted eye. But for the naked eye this value is known, or may be readily determined.

If, for example, the value for the naked eye be taken, according to Helmholz, at 240 m., then the maximum limit for the instrument is $240 \times 135 = 32{,}400$ m.

For a distance of 500 m. however, the error of observation is 7.7 m., or 1.55% for 1000 m. it is 21 m., or 3.1%, etc.

It would be more correct and of more practical use, to determine the error of observation empirically, by repeated measurements, in which, of course, the personal error of the observer has its effect.

I carried out a number of measurements of this kind with the greatest care; two series are given here by way of example:

	1st Distance. Office of Military Committee to Karlskirche.		2nd Distance. Office of Military Committee to Russian Church.	
Readings.	606 m.	612 m.	1,350 m.	1,360 m.
	610 m.	608 m.	1,350 m.	1,340 m.
	605 m.	612 m.	1,330 m.	1,380 m.
	602 m.	608 m.	1,340 m.	1,360 m.
	610 m.	610 m.	1,330 m.	1,340 m.

From these readings, at the range of 600 m., there is a mean error of $\pm$ 5 m., at that of 1,350 m., a mean error of $\pm$ 25 m , or, in percentages of the range, 0.82% and 1.86% error, respectively.

As an average of all measurements carried out in this way, a mean error of 0.785%, at the range of 500 m., was obtained. According to the quadratic law of increase of error, therefore, we will obtain :

For 500 m. an error of 0.785%.
For 1000 m. an error of 1.57%.
For 2000 m. an error of 3.14%.
For 4000 m. an error of 6.28%.
For 8000 m. an error of 12.56%.

From this it follows that for distances over 4000 m., an instrument with a base of only 87 cm. is no longer adequate, especially in view of the fact that as a rule the measurement of distances is not carried out with the care and exactness that was exercised in taking the above distances. Moreover, it is possible to measure with such accuracy only when the object stands out against a clear horizon.

With a dark back-ground, such as woods, mountain slopes, meadows, buildings and walls close behind the object, the degree of accuracy of the measurements falls considerably, so that even at 2000 or 3000 m. results are obtained which hardly meet the requirements of accuracy for modern guns.

From a theoretical standpoint it is worthy of notice that the limits of error of the instrument determined by actual measurement are smaller than those calculated from Helmholtz's formula and given above. For example, at 500 m. the error determined by actual use of the instrument is 0.785% ; whereas the formula gives 1.50%, or nearly twice as much.

This fact may, however, be readily explained. The theoretical calculation is based on the assumption that the definition of the telescopes of the range-finder is 6 angular seconds, while that of the naked eye is 60 seconds. This is approximately true for black lines on a white field, which, are the conditions under which the tests are made. But, in the observation of distant objects, which stand out distinctly against the horizon, the clearness of vision of the naked eye is undoubtedly greater than 60 seconds of arc; under such favorable circumstances, therefore, the arc may be much smaller; and as I stated in my previous article, experiment shows that it is possible to detect differences of 33 seconds of arc.

In that case, however, the limit F is no longer 240 m., as von Helmholz determined it, but about 470 m., so that the theoretical limit of error is almost exactly half as great as the one assumed, viz : 240, a fact which agrees perfectly with the results of practical experiment.

CONCLUSIONS.

If we assume that other persons besides those who have become experienced in the handling of this instrument must be able to measure ranges with

it, then the instrument must be considerably improved in order that its degree of accuracy may be sufficiently high that with an average personal error of observation it may give ranges of sufficient accuracy to meet the requirements of modern firing.

If we assume 3 m. as the greatest allowable distance between the telescopes, hence, $\frac{3000}{65} = 46$ times the natural distance between the eyes, and a defining power of 3 seconds of arc (40 times), or 20 times greater than that of the naked eye, such an instrument would permit of a stereoscopic observing power $20 \times 46 = 920$ times as great as with the naked eye.

According to our previous calculations such an instrument—assuming an experienced observer—would have an error of observation of 0.35% at 1500 m., 0.7% at 3000 m., and 1.4% at 6000 m., therefore, even with poorer adjustment by observers of less experience, would give measurements of sufficient accuracy.

[Translated by Captain J. P. Wisser, 7th Artillery.]

FORTIFICATIONS.

Cover For Field Artillery.

Protection for the cannoneers is the first consideration, and only when sufficient time is available is cover for the guns to be thought of. Cover for the men, unless the ground be exceptionally unfavorable, can often be constructed in an offensive action and during the firing. The fighting capacity of the battery must not, however, be interfered with in the least.

The construction of complete gun-pits, on the other hand, will generally be possible only in defensive positions previously prepared, before opening fire.

In arranging such cover it should be noted that *observation* should be made as difficult as possible for the enemy. With this object in view (if time permits) earthworks and other masks are thrown up. It may, however, be advantageous to connect the separate gun-pits by a thin parapet of the same height, because a continuous line is less distinctly visible than a broken one. But such a connecting parapet must not interfere with the free movement of the guns forward.

Unskillfully constructed cover often offers the only means of detecting the position, and in that case does more harm than good.

Furthermore, under certain circumstances it may become necessary to strengthen the profile of the gun-pits, and to dig connecting ditches between the guns and the batteries.

Whenever possible, cuts, ditches, embankments, and crests are utilized as natural parapets.

When required, measures are taken to facilitate the advance of the guns for the close-range action.

The interval between guns, measured from center to center, is ordinarily about 20 paces; when necessary, a diminution of this interval to 10 paces is permissible; it is not essential that the intervals should be equal.

Intervals between batteries, of about 30 paces, are desirable for the proper conduct of the fire, but must not be obtained at the expense of the intervals between pieces.

The gun-pit must not be so deep as to limit the field of fire.

In dry, sandy soil the firing will blow up so much dust from the parapet that the advantage of using smokeless powder is lost. In that case it will often be better to give up having any parapet immediately in front of the gun.

In soft ground planks, etc., for the trail and wheels to rest on, may b
useful. If time is pressing only the pits for the cannoneers are const
the piece resting on the natural ground. A parapet, in this case,
thrown up later from an exterior ditch.

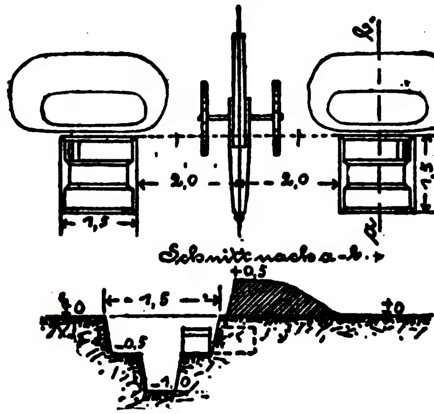

Fig. 1.

The accompanying
illustrate models, whic
ever, are not to be rega
in any sense binding
whatever form of c
adopted it must under
cumstances be such as t
fere with the free ser
the pieces.

From the center of th
tion of the piece dista
2 m. are laid off to the r
left of the axis to m
corners of two pits for
noneers, square in sha
1.5 m. on the side. Th
of the squares is on
passing half way between the axle and the rear of the tires. Two
men are set to work on each pit. The pits are first excavated to a d
0.5 m., then, leaving a seat on the front slope and a step on the rear slope, the depth is increased t o1 m.

The earth thrown out is utilized to form a parapet, first in front of the pits, then on the sides, and this is afterwards packed down. Pits for the ammunition (including projectile cases, cartridge pouches, etc.) are then dug above the seat on the front slope, in natural ground. (Fig 1).

The construction of the pits for the men, by the cannoneers themselves, in average ground, requires 25 minutes.

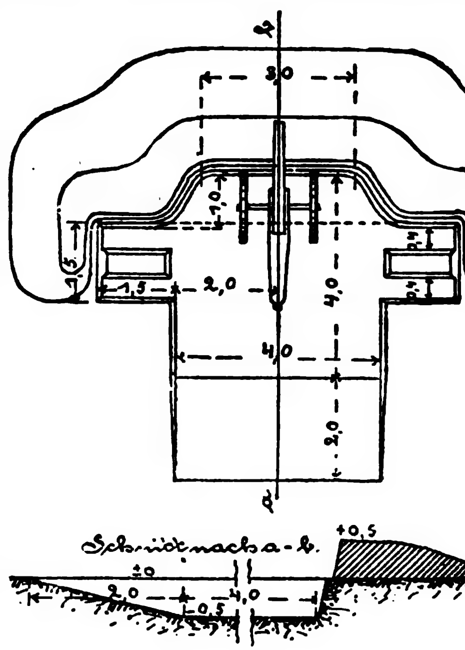

Fig. 2

In case the time required to excavate a
complete gun pit (Fig 2) requiring for 8 men in average ground abou
—is not available, the pits for the cannoneers should be finished a
But, if the necessary time is available, gun pits and cannoneer pits

commenced at the same time, and, if necessary, another detachment of men can be utilized to dig the trench in front.

Fig. 3

If the guns are to be placed on reverse slopes an arrangement like Fig. 3 may be resorted to.

Under certain circumstance an excavation in the scarp for the wheeis. and an enbankment of earth behind the latter and the trail may be sufficient. The cuts for the wheels must be three or four times as wide as the tires.

During the firing it will often be necessary to repair injuries to the pit or epaulment.

—*Felbefestigungs-Vorsehrift*, 1893.

MILITARY GEOGRAPHY.

Harbors and Waterways.

Although the past year has not been noticeable for the inauguration or completion of any works of great importance in connection with docks and harbors of this kingdom, yet schemes of considerable magnitude have been under consideration in order to provide for the increased and rapidly increasing size of vessels. It is a realized fact that the larger the vessel in which grain and other merchandise is brought from long distant ports, the less the cost of transit. Having regard to the keen competition which exists, not only with the shipowners of this country, but also with those of other nations - more especially with the subsidised companies of Germany—it becomes necessary for our large shipowners to follow a forward policy. Consequently the size of vessels is continually increasing, steamers being now built of a length and draught that would have been deemed utterly impossible only a few years ago.

The Suez Canal used to be considered as regulating the size and draught of the vessels which had to be provided for in the docks of this country and to this standard the depth of the water in the channels, and over the entrances, and the length of the locks, have in most of the principal ports been adapted. This condition was fully met by any port which had a lock 500 feet long, with a depth over the sill of 26 feet. It has, however, been found necessary to deepen the Canal, and three years ago the depth was made 28 feet, and the deepening is to be continued until 30 feet is reached. A port that provides only 26 feet now can only be expected to be placed in the second class. Vessels over 700 feet long are being constructed, requiring a depth of from 28ft. to 30ft., and where passenger traffic has to be dealt with, the port that can afford to give this depth at all states of the tide must have the greatest advantage.

For the American liners a depth of 30ft. at low water is hardly considered sufficient. It is less than ten years ago that it was considered necessary by the United States Government to deepen the approach to the sea, from New York from 24ft. to 30ft. at low water. Steamers there have the advantage of berthing at piers in the harbor without going into dock. During the last year the Government have had under consideration the necessity of still further deepening the channel, so as to give 35ft. Twenty years ago there were

only eight steamers running between this country and America which drew 27ft.; ten years ago there were twenty-eight such steamers, the maximum draught being 28ft. 4in. Last year the number had risen to thirty-three, drawing between 27ft. and 28ft.; sixteen between 28ft. and 29ft., and nine which exceed 29ft., the maximum being 30ft. 6in. The draught of the Oceanic now building is reported to be 32ft., and of the cargo boat Cymric, 29ft. 2in. The Hamburg American boat, Kaiser Wilhelm der Grosse draws 28ft. 3in., and other new vessels being constructed for this Company are expected to draw 32ft. The draught of the Peninsular and Oriental steamers and of the British India Company is about 26ft; the New Zealand liners draw 27ft. For the safe navigation of a vessel a considerable margin must be added to these figures.

It used to be held as a commercial maxim that the further merchandise could be carried into the interior of the country, and the nearer to the large centers of distribution, in one bottom, the more economical the cost of distribution, without any proportionate increase of freight, and that it was a mistaken policy to place docks at any great distance from the town to which they were appurtenant. This was one great argument used in favor of the Manchester Ship Canal, and it is to the inland position of Goole, nearly fifty miles from the sea coast, and its proximity to the centers of manufacture, that in spite of the difficulty of the navigation, and the powerful railway interest with which it had to contend, the growth of its trade has been due. It was due also to a neglect of this principle that Tilbury Dock, owing to its distance from London, was for some time after its construction, a failure; and also that Avonmouth and Portishead, owing to their distance from Bristol, barely earned sufficient to pay working expenses. The Coble Dene Dock, on the Tyne, being situated far away from Newcastle, and the Greenock docks, on the Clyde, owing to their distance from Glasgow, have never yet answered the expectations formed when they were promoted. It would be folly to apply this maxim to the modern leviathans, and ruinous to attempt to bring the approaches of ports situated at any great distance from the coast up to a standard sufficient for the navigation of vessels of this class. With ports of the first class it becomes, however, an absolute necessity to meet the growing demands of the shipowners, who are continually building larger and larger vessels, requiring deeper draught. Unless provision is made for these at the port which has hitherto been used, the business will be removed to other places. So rapid during the last few years has been the development of long and deep draughted vessels that even before improvements designed to meet the growing requirements have been carried out, they have become almost out of date. Shipowners keep on building larger vessels, and indicate that the limit has by no means been reached. While, however, a vessel may be designed and constructed in a little more than a year, it takes five or six years to remodel a dock system that will provide the necessary accomodation for her.

The vessels engaged in carrying the long-distance freights form, however, only a small portion of the merchantile marine, and there still remains the much larger traffic engaged in the continental and short distance lines. The result, therefore, must ultimately be that the leviathans of the trade will be confined to a few firstclass ports, whence their cargoes will be distributed by coasting steamers. Even with this extra cost in distributing the cargo, it will be found that the cost of transit will be less in large bottoms than in vessels of more moderate dimensions.

The only English port that fulfils the conditions of the steamers of the future is Southampton, with its 30ft. at low water, the American passenger steamers being able at all states of the tide to run along the railway quays without any loss of time in locking into docks. Although the Thames Commission in their report admitted that a depth of 30ft. at low water was desirable, the Commissioners at present are content with deepening the lower part of the channel to 26ft at low water. Accommodations in the Thames for the embarking of passengers and the loading and unloading of cargo can only be obtained in the docks, and the delay in locking in, out, and waiting for the tide, is therefore unavoidable. At Tilbury there is a depth of 22ft. on the sill of the lock at low water, and 37ft H. W. N. T., with a lock 700ft. long. Further up the river, at the Albert Dock, there is 17ft. at low water, and 31ft. at high water of neap tides, with a lock 550ft. long. It is intended to dredge the low-water channel to 22ft. at low water up to this dock. At Liverpool vessels have to contend with a strong sun of tide and a rise and fall 27½ ft. at spring and 20½ft. at low at neap tides. Very great improvements have been made by dredging and deepening the channel so that the delay that used to occur in passing over the bar is now avoided, and by enabling the large American liners to receive and discharge their passengers at the Prince's Landing Stage, to which the railway has been brought; but these vessels, after landing their passengers, have to go into dock to discharge and receive their cargoes. The depth of water at H. W. N. T. on the sill of the Canada Lock is 26ft. and at low water is 6ft., the lock being 600ft. long. The depth along the channel dredged through the bar at low water at spring tides is 23ft. The dredging has been continued during the past year with satisfactory results, the channel not only maintaining its depth, but tending to deepen. The extensive works commenced a few years ago have during the past year made considerable progress, and when completed will give 3[illegible]ft. on the sill of the Sandon Dock entrance at high-water neap tides, and 12½ft. at low-water springs.

It was recenily admitted by one of the most active members of the Mersey Docks and Harbor Board that Liverpool is at least ten years behind its trade but during the past year the Board have entered upon a spirited line of forward policy, and have decided, as far as possible to bring the port up to date, and to provide for a long while ahead. The scheme, which involves an expenditure of 3½ millions, was decided on too late to allow of the necessary powers being obtained in the coming session of Parliment; but this is of less importance as the works now in hand, and to which those now in contemplation are a continuation, will take a considerable time to finish. When the new scheme is completed, provision will be made for any number of vessels 800ft. long, and for a large number 900ft. in length, with graving docks of sufficient capacity to repair them.

Bristol, which at one time was the principal port for trade with our American Colonies, and which had recently fallen into a very second-rate position, is now reviving and making great efforts to secure a share of the Canadian and long-distance traffic. In addition to considerable improvements for facilitating the passage of vessels up the Avon to Bristol, the docks at Avonmouth have been considerably improved and brought more up to date. Already a considerable trade has been created with Canada, and works are being carried out for adding to the lock so as to admit vessels of 480ft. in length, and giving a depth of 28ft. at high water neaps, in order to provide for the large cargo vessels being constructed for the Bristol and American and Canadian trade. It is even hoped to build up a passenger trade, Boston to Bristol. To

meet the requirements of the growing trade the Corporation decided to spend $1\frac{1}{2}$ millions in building a new deep-water dock at Avonmouth, with a lock 850ft. long, with a depth of 30ft. in the dock. The proposed scheme involves very considerable alterations in the railways and as complicated questions have to be settled with the Great Western and Midland Companies, it was not found possible to complete the plans in time to prepare a Bill for the coming Session.

The spirit of rivalry in the great passenger trade with America and the distant Colonies, which Southampton has provoked, has stirred up Plymouth and a scheme is now under consideration of the Corporation for deepening the entrance to the harbour to 30ft. at low water, and for constructing new deep-water quays for the landing of passengers and goods. This scheme is estimated to cost less than half a million. With the advantages that Plymouth possesses in her fine sheltered harbour of 200 acres, and safe anchorage in 39ft. at low water and moderate rise of tide, there is nothing to prevent her fulfilling the conditions of a first class port for passenger traffic at a moderate cost. For merchandise the long distance from the large manufacturing and commercial towns must be a drawback.

The East Coast ports deal more with the Baltic and the Continent than with America and the Colonies, and consequently there has been less stimulus to provide deep-water accomodation. The Humber, which has the largest general trade on this coast in its natural condition, gives a sufficient depth of channel for steamers of considerable size to navigate at low water, there being from 25ft. to 30ft. to a little above the Alexandra Dock of the Hull and Barnsley Railway. The channel then becomes narrower and its position more variable, the depth falling to about 21ft. at the approach to the Albert Dock of the North-Eastern system. The Alexandra Dock has 12ft. at low water over the dock sill at low water S. T., and 28ft. at H. W. N. T., the length of the lock being 550ft. The Bill promoted by the North-Eastern Company during the last Session, by which it was proposed to expend nearly a million of money in alteration to the Hull Docks, if it had been successful could in no sense be regarded as providing accommodations necessary to raise Hull to the condition of a first-class port, but rather as intended to faciliate the arrival and dispatch of the steamers èngaged in the Continental and short-distance trades in competition with Goole. The Albert Dock, in which the largest vessels are berthed, was intended to have been lengthened to 600ft., with the sill so placed as to give 13ft. L. W. S. T. and 29ft. at H. W. N. T. The approach to the Humber Dock, the principal receptacle for the continental steamers, was to be through a lock only 300ft. long, with 15ft. on the sill at L. W. S. T. and 31ft. at H. W. N. T. While thus there would have been a fair depth at high water, the short length of the lock would not have allowed the passage of large steamers through it, while the depth on the sill of the Albert Dock would only have allowed the passage of the largest class of cargo steamers at S. T. Of the other principal ports on the East Coast, the Albert Edward Dock—the deepest on the Tyne—has only 26ft. at H. W. N. T., and 16ft at low water, the Northumberland Dock 20ft. at H. W. N. T., and the lock of the Tyne Dock has recently been deepened so as to give 27ft. at H. W. N. T. At Leith at present the entrance channel is obstructed by a bar, on which there is only 10ft. at L. W. S. T., and the depth over the deepest dock sill is about 8ft. at L. W. S. T. and 21ft. at H. W. N. T. The new dock which has been in course of construction for some time past, has made considerable progress during the past year, but it will take about two more years

to complete. The sill of the lock of this new dock is to be 5ft. deeper than that of the existing dock.

At Glasgow the new Cessnock Dock, which has been in course of construction for some years past, and partially in use, was formally opened during the year by the Duchess of York, and is in future to be known as the Prince's Dock. The water area of these docks is 34½ acres. The depth of water at L. W. S. T. varies from 20ft. to 28ft., according to the position in the dock, and from 29ft. to 37ft. at H. W. N. T. The basin is tidal, there being no locks, the variation of level at spring tides being 11ft. Provision has been made in the new dock for canting steamers up to 700ft. in length on the water-line, and drawing 28ft. It is interesting to note the progressive increase in depth of water of the tidal docks which have been constructed on the Clyde. Up to 1865 the sides of the harbour afforded sufficient accommodation; the Kingston Dock was then constructed, having 10ft. at low water. The Stobcross or Queen's Dock, constructed in 1870, has 16ft. to 20ft. at low water; while the dock now completed has from 4ft. to 8ft. greater depth. A graving dock 880 ft. long by 80 ft. wide forms part of the new system.

Looking at our rivals across the water, the Belgian Government is spending a large amount of money in building a new port at Heyst, where provision is to be made for vessels drawing 26¼ ft. at low water to discharge alongside the railway lines which are to run along the quays to be made on the moles which are being built out from the coast line, and with which considerable progress has been made during the past year. At Antwerp where already six millions has been spent on the improvement of the harbor, and where vessels drawing from 28ft. to 30ft. can moor alongside the river quays, the Government during the past year, has decided to carry out still further improvements by cutting off a sharp bend in the river, and converting the loop cut off into docks. Extensive works have also been carried out for improving the port of Ostend and it has been decided to dredge a second deep-water channel through the Stroombank, so as to improve the approach to the harbour from the north. At Bremerhaven, where already considerable works have been carried out in constructing docks and quays, and a new deep-water wet dock of 30 acres in extent has recently been completed, at a cost of nearly a million of money. The lock of this new wet dock is 721ft. long and capable of takink vessels 656ft. in length and 90ft. in width. The depth of water maintained in the dock is 33ft. 9in. A dry dock of sufficient dimensions for docking vessels 656ft. long and 82ft. wide has also been completed.

As regards harbor and dock work generally, the Bills promoted in Parliment were not of great importance, and misfortune befell most of those introduced. The North-Eastern Company failed to carry its Bill for the improvement of Hull Docks, but obtained the necessary power to carry out improvements much needed at Middlesbrough. The promoters of the Bill for constructing the Windsor Dock, at Cardiff, were a second time unsuccessful, and the Kilpatrick Dock on the Clyde shared the same fate. The Midland Railway Company obtained powers to construct a new harbor for its Irish traffic at Heysham, and the work has been already commenced. At Llanelly, where powers had been obtained by the Harbor Authority in the previous session to construct a new dock, the preliminaries as to raising the money and other matters have now been settled, and tenders obtained from contractors for carrying out the work. At Burntisland the contract for the new dock has been let and works commenced.

During the year the names of the owners of two well-known docks have

been changed, the Bute Docks being now under charge of the Cardiff railway company, and the Manchester, Sheffield and Lincolnshire Docks at Grimsby. being in future to be known as part of the Great Central Railway Company.

With regard to harbors, this article would not be complete without some reference to the final decision of the Government to proceed with the harbor of refuge at Dover after more than 40 years' consideration, and the acceptance of a tender for the works for a sum approximating three and one-half millions; or to the extensive contract of over three millions, which is being carried out at Keysham, in constructing a new dock for the accomodation of the Navy.

At Tynemouth the disaster to the North Pier, due to a severe gale in January last, which had just been completed, after 40 years' work, involving a further outlay of £300,000 to make good the damage, and the death of Mr. P. J. Messent, who had been in charge of the work from its commencement, are both matters of universal regret.

Inland navigation, which a few years ago appeared to be undergoing a revival, has relapsed into its former state of lethargy. The bargee, with his old-fashioned craft and slow-going horse, has resisted being improved off the face of the earth by steam and modern appliances. Some few attempts have been made at improvement, but these have not been attended with such success as to give much encouragement to others to follow the example. Singularly enough, one of the canals which is being improved belongs to a railway company which has always been held up by canal enthusiasts as the great cause of canal decay and the barrier to all improvement. The North Staffordshire Railway Company has been engaged during the past year in doubling the locks on the Trent and Mersey Canal, and otherwise improving the navigation to meet the requiremenls of the large traffic which has to be dealt with. The works for improving the Thames and Severn Canal. which was placed in the hands of a Trust in the previous year, have proceeded during the past year, and are now approaching completion. A similar attempt has been made to form a public trust to take over the almost derelict canal between Tewkesbury and Stratford-on-Avon, but beyond preliminary negotiations and reports, the matter has not so far reached a practicable shape. The works which were carried out for improving the navigation of the Severn, so as to allow coasting steamers to get to Worcester from the Bristol Channel, have not succeeded in attracting the expected traffic; and the scheme brought forward during the year for further improving the waterway on to Birmingham, which was well taken up. has, so far as any outward evidence shows, died a natural death. The Ouse navigation between Lynn and Bedford, which has been improved and put in order by the owner at a large outlay, does not appear to have been so far a very successful venture, as notice has been given that the navigation is to be closed.

Coming to larger navigations, the Manchester Ship Canal, although its promoters appear to be using all the inducements possible to attract trade, still lags a very long way behind being a successful concern, and during the past year although trade has increased, the increase is not encouraging. A feeling appears to be growing that more attention should be given to what is termed the barge traffic and recently a scheme which has been hatching for some time past, but held in obeyance owing to the opposition of the Canal Company appears now to be approaching a definite form. It is contemplated to form a Transport Company, consisting of representatives of several of the largest

shipping firms, for running steam barges carrying 1000 tons for the transport of goods between Liverpool and Manchester, by which a large assortment of goods is conveyed between the two places: and the proposed new Company intends to develop this to a much greater degree. Although at the time the canal was built it was thought that the depth of water—26ft.—and the length of the locks—600ft.—was sufficient for the large steamers trading across the Atlantic, the new development in the increase of size will render the navigation impracticable by the largest class of vessels, and a barge service will become a necessity.

The Panama Canal survives in a state of suspended animation. Work is still going on, but of a tentative character, and no attempt has yet been made to raise the many millions that would be required to complete it. Of the Nicaragua Canal little or nothing has been heard during the past year. Both the Baltic and Corinth Canals have failed to attract the traffic expected, and complaints are heard as to the difficulty in navigating the former owing to the sharpness of the curves and want of depth.

The question of inland waterways has during the past year attracted a very great deal of attention in Canada and the United States, and each Government has been having inquiries made as to the best means of opening up communication for vessels of sufficient size to navigate the Atlantic between the Great Lakes and the sea. The Canadians, after spending a large sum of money in constructing the Sault St. Marie canal and locks on Canadian territory, and otherwise improving their navigation, still find that the greater part of the traffic finds its way through New York. A great effort is now to be made to deepen the whole canal system, so as to bring the traffic from the lakes entirely thorugh Canadian territory to the St. Lawrence, and so to the Atlantic and this country. On the other hand the United States Government have had preliminary surveys made as to the best route for a ship canal giving 26ft. of water, to bring the traffic by the Hudson to New York. The cost however, estimated at £40,000,000, is judged to be too great for the advantages to be obtained. On this side of the water the matter has attracted so much attention that the Danish Government have had prepared a report on "Chicago as a Seaport," which deals in the most complete manner with the reciprocal advantage to Europe from a cheap supply of food from the vast territories bordering on the American Lakes, and in the export of manufactures and goods to the towns and villages rapidly springing into existence. Already several steamers have carried cargoes direct from Chicago to Norway at renumerative rates, and the Danish minister, who has caused the phamplet to be prepared, gives sufficient facts to show that the cultivation of such a trade would be of great service to Denmark. The facts and arguments apply with still greater force to this country, and are well worth the consideration of those shipowners who often find a difficulty in finding a new port for their vessels.

Nothing practical has been done the past year with the scheme for improving the decaying trade of Marseilles by the construction of a canal connecting that port with the Rhone, which in the early part of the year attracted much attention. In Russia, however, there is every prospect that the gigantic project for constructing a canal 1000 miles long, to run right through the length of the country from the Black Sea to the Baltic, of sufficient capacity to allow of the largest vessels of the Navy passing from one sea to the other, at a cost of £20,000,000, will go forward. The surveys are being completed, and it is

stated work will be commenced in the coming year. Already the harbors at Cherson and Riga, the two terminal points, are being improved.

The Engineer, January 7, 1898.

WARSHIPS AND TORPEDO BOATS.

Wanted: Faster Battleships.

The Board of Construction of the Navy Department has decided that the three new battleships just provided for by Congress shall have speeds of only 15 to 16 knots. Commodore Melville, Chief of the Bureau of Steam Engineering, and a member of the Board of Construction, submitted designs for propelling machinery adapted to give these vessels a speed named above.

In taking this action, it seems to us that the Board of Construction have made a serious error, and one of too much public importance to be passed over without notice. If it is worth while for the taxpayers of the United States to go down into their pockets for some fifteen million dollars, to add three new battleships to their navy, it is surely worth while to see to it that these vessels shall be equal or superior to any similar vessels afloat or under construction for European navies.

The American public is taking a far greater interest in naval matters this year than it has ever taken since the gallant exploits of 1812. If it is once clearly understood that the three newest battleships for which its representatives have appropriated funds are to be from two to four knots slower in speed than the latest European battleships, a general protest will certainly be heard against the decision of the Naval Construction Board.

It ought not to be necessary, in the light of the events of the past month, to explain to any American reader the enormous advantages of high speed in naval warfare. Had Spain's Cape Verde squadron of 20-knot armored been able to take in a full equipment of coal and supplies at any port on this side of the Atlantic and then start out on a cruise, we should have had an illustration and a pretty costly one of the value of high speed. We do not mean that they could probably have done any very serious damage to coast towns; but they could have done an amount of injury to our naval vessels and our shipping of most serious proportions. Let it be remembered that out of the entire United States navy of over 200 vessels, we have only seven (aside from the monitors) whose guns and armor are sufficient for them to engage such vessels as the *Vizcaya* with any chance of success. Of these only two have speeds equal to those of the Spanish cruisers. Further, we have in our whole navy only six vessels, all told, with speeds approaching theirs, and four of these have not armor enough to engage them. Had Cervera's vessels once got a chance with full coal bunkers to sail along the Atlantic coast, practically our whole navy and all our coast shipping would have had to seek refuge in harbors to escape capture, and our slow-speed battleships would have been powerless to catch and punish the invaders.

By the most able generalship on the part of our naval commanders we have been fortunately delivered from a situation fraught with more peril than one American citizen in ten thousand realizes. But although we have been spared from learning in the dear school of experience what superior speed means in naval warfare, we have come so near to the brink that we shall be fools beyond measure if we do not take immediate steps to see that we are not again caught in so risky a situation.

This journal has repeatedly called attention to our great need of fast

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armored cruisers, yet none whatever have been provided for in the Naval Appropriation bill. Instead, we have three more battleships to add to the four already in commission, and the five which are now under construction, and these new vessels, as we said above, are to be far inferior in speed to the latest battleships of European countries.

The only excuse thus far published by the Board of Construction for turning down Commodore Melville's designs for 18-knot vessels is that these designs would necessitate changing the plans for the interior construction of the vessels considerably, and thus postpone by several months the date of letting the contracts, and the time of completion of the vessels. This excuse, however, seems to us far from sufficient. We are now at war with a European power and getting along fairly well with only four battleships of the first class. With the five more which we have now well advanced toward completion, we are at least not so badly off that we can afford to take an inferior article for the sake of getting it a little sooner

We have aluded above to the speeds of recent foreign battleships. It may be interesting at the present time to see just what foreign nations possess in the shape of fast battleships. Turning first to England, which leads the world in naval construction, we find that the latest type of battleship which her naval constructors have developed are expected to have speeds approaching 19 knots. Six of these great vessels, the *Canopus*, *Goliath*, *Ocean*, *Albion*, *Glory* and *Vengeance* are now nearing completion. They have a displacement of 12,950 tons and triple expansion engines of 13,500 I. HP. These vessels are very similar to the famous *Renown*, a battleship of 12,350 tons, which was launched in 1895 The *Renown* has engines of 12,000 I. HP., and on her four-hours' run under forced draft showed an average speed of 18.75 knots, developing 12,900 HP. In an 8-hour run under natural draft she averaged 17.9 knots, with 10,708 HP.

The *Magnificent*, *Majestic*, *Mars* and *Jupiter*, form a quartette of huge vessels of 14,900 tons displacement. Each of them has engines of 12,000 I. HP. These vessels had their trial trips in 1895 and 1897. The horsepowers and speeds were as follows:

Vessel.	Indicated horsepower. Natural draft.	Indicated horsepower. Forced draft.	Speed. Knots per hour. Natural draft.	Speed. Knots per hour. Forced draft.
Magnificent . . .	10,301	12,157	16.5	17.6
Majestic	10,418	12,497	16.9	17.9
Mars	10,159	12,434	16.0	17.7
Jupiter	10,248	12,475	15.8	18.4

The *Prince George*, *Victorious*, *Caesar*, *Hannibal* and *Illustrious* are of the same displacement and horsepower as the four above-named, and have practically the same speed. These nine vessels are the largest naval vessels afloat, except Italy's *Italia* and *Lepanto*, the latter of 15,900 tons displacement. Great Britain is now building three more battleships with the same displacement as the vessels of the *Majestic* class, and they are planned for even greater speed, 18.75 knots.

All the vessels above named have been launched or put under construction within the past five years. Among the older English battleships, however, we find no less than ten with nominal speeds of 17.5 and 18.2 knots. In fact

not since 1885 has an English battleship been launched, designed for a speed below 16.7 knots.

It is of interest to note that the *Iowa* is the only one of our battleships that reached a 17-knot speed on her contract trial. Our five new battleships now building are each to have a displacement of 11,525 tons and a nominal speed of 16 knots.

Turning next to France, the second naval power of the world, we find that she has at least eight battleships with speeds in excess of any United States battleships. The *Charles Martel*, a 11,900-ton battleship, on her four-hours speed trial, in May, 1897, made a speed of 18.13 knots, with 15,000 horse power. The *Jaureguiberry* and the *Carnot*, are two other battleships each of 11,800 tons which had their steam trials in the spring of 1891. The former made 17.65 knots, and the latter 17.9 knots on the average with a maximum of 18.5 knots.

The *Charlamagne*, *Saint Louis*, and *Gaulois* are battleships of 11,000 tons, designed for a speed of 18 knots. The *Massena*, launched in 1895, is a triple-sciew battleship with engines of 13,5000 I. HP., designed to give a speed of 17.5 knots. The *Bouvet*, launched in 1896, is a sister ship to the *Massena*.

Germany, as many of our readers will recall, is taking up the matter of naval construction in a vigorous way, and as a German shipyard has built the two fastest transatlantic liners afloat, we may be sure that her new naval vessels will not lack in the matter of speed, whatever her old-style ships may have done. The *Kaiser Friederich III.*, launched in July, 1896, is a triple-screw battleship of 11,050 tons, with engines designed to give 13,000 I. HP., and a speed of 18 knots. The new *Kaiser Wilhelm II.*, launched last year, and the *König Wilhelm.*, under construction at Keil, are sister vessels with the same displacement and speed as the above.

Italy, notwithstanding her poverty, has a naval force of no mean proportions. The *Ammiraglio di St. Bon*, a 9,860-ton battleship, was launched a year ago, and is designed for a speed of 18 knots. The *Emanuele Filiberto*, is a sister vessel with the same dimensions. The *Sicilia* is a battleship which had her steam trials in 1895, and is reported to have made an average speed of 19,3 knots under natural draught alone. The *Sardegna* is a battleship of 15,000 I. HP., which in her contract trial, four years ago, made an average speed of 19.64 knots.

The *Re Umberto*, launched ten years ago, has a speed of 18.5 knots, while the gigantic *Lepanto*, now 15 years old, has a speed of 18.4 knots.

Rüssia has three battleships launched in 1894 and 1895, the *Poltava*, *Petropavolsk*, and *Sevastopol*, which are each 10,960 tons displacement with engines of 13,500 I. HP., designed to give a speed of 17.5 knots. That these speeds for Russian vessels are not overestimated by their constructors seems evident from the fact that the Russian battleship, *Tri Sviatetelia* in a 12-hour speed trial, attained a speed of 18 knots, although her contract called for only 16 knots. The newest Russian battleship, for which orders have recently been placed with the Cramp shipyard in Philadelphia, is to have a speed of at least 18 knots.

Japan has two English-built battleships, the *Fuji* and *Yashima*, launched in March, 1896, each of 12,320 tons displacement, with propelling machinery of 13,500 I. HP., designed to give a speed of 18.25 knots.

It will be seen by the preceeding hasty review, that *there are at least*

FIFTY battleships already afloat or under construction which have speeds of one to three knots in excess of the speed of any battleships of the United States.

During the decade from 1880 to 1890, speeds of from 15 to 16 knots were generally accepted as standard speeds for battleships the world over. At the present time speeds of from 17 to 19 knots are equally accepted as the standard for battleships by the principal naval powers. Not one of these powers would think, at the present time of building first-class battleships for any lower speed. To do so would not only result in a vessel of obsolete type, but would seriously injure the naval prestige of any power.

In the face of this action, by all the naval powers of the world, our own naval authorities have adopted a course which may result in the three new battleships for which contracts are about to be let, being even slower than those now in commission. When the *Indiana*, *Oregon*, and *Massachusetts*, were built, the contractors were offered a premium for securing high speed, and the *Oregon*, which was designed for a speed of 15 knots, actually made 16.79 knots in her contract trials. But as the result of a clamor, started for political effect, Congress has forbidden giving premiums for high-speed. The Navy Department, in its circular to shipbuilders, announces that the new battleships will be accepted if they reach a speed of only 15 knots on their contract trial. The contractor is subjected to a moderate penalty for each quarter knot deficiency in speed below 16 knots; but he has no incentive whatever to build a vessel that will do better than 16 knots, and there is no reason to expect they will do it.

We have always contended that the withdrawal of speed premiums to builders of naval vessels was a piece of penny-wise economy. Those who brought it about prated about the saving made in amount of the premium, and wholly forgot that the shipbuilder, in making his original bid, took into consideration the amount of speed premium he could fairly count on receiving. Further, the speed made in the contract trial run of four hours is no such false index of the speed under service conditions; as has been claimed. No better proof of this could be given than the magdificient voyage of the *Oregon*, and the high speed records which she made after cruising ten thousand miles and with engine and fire-room forces suffering from the heat of the tropics.

Turning again to the speed requirements for our newest battleships, it should be noted that the Bureau of Steam Engineering is not at fault. They have offered plans for 18 knot vessels, involving the latest types of water-tube boilers and quadruple expansion engines, and promising a saving of weight 350 tons. Every other naval power in the world is making use of the water-tube boilers. We cannot ignore the progress of other countries and placidly say that what has been used in the past is good enough for us, if we propose to make good the international obligations which we have undertaken.

We are aware that the adoption of water-tube boilers has caused a vast amount of criticism in foreign navies, and experiments with them in this country in marine service have not been an entire success; but other countries have not abandoned the use of these boilers on account of the difficulty but have gone on to improve and perfect them. Surely, if Frenchmen and Italians and Russians can adopt and use these boilers, Americans, with their well-won reputation for mechanical skill, can do at least as much.

We are aware, also, that in the past the theory has obtained in Congress, and possibly in the Navy Department as well, that our navy was designed solely for defense, and that low speeds and small coal capacity were all right

for American naval vessels. The fallacy on which this assumption rests has been well shown of late by that acknowledged authority on naval strategy, Capt. Mahan; and in the light of the object lessons of the past two months, it hardly seems possible that it can enter as a factor into the design of our newest battleships. It ought to be plain to everyone now that attack is the best defense, and the policy of building monitors, which, by good rights, ought never to be sent to sea at all, and expecting our gallant admirals to tow them along when they go gunning after 20-knot cruisers, is a policy that ought to be laid on the shelf. The nation will not be satisfied with a navy for coast defense, merely, but demands that our vessels shall have speed enough and strength enough to protect our commerce on the high seas.

American shipyards are building vessels for the navies of Japan and Russia. If they can build 18-knot battleships for the latter country, they can do it for our own, if our naval authorities will only require it of them.

Finally, let it be understood that in the criticism we have made, we are expressing no opinion as to the wisdom of increasing the size of our navy. We are by no means inclined to join in the popular clamor, which urges that we compete with the greatest European nations in our naval establishment. We do urge that the weak places in our naval forces which the present war has brought to public attention, shall be strengthened, and that every new vessel we build shall be at least as good in every respect as the latest vessels of its type abroad. We have no hesitation in saying that if our new battleships cannot be placed at least on a par with the best of foreign navies, it will be better for the reputation of the United States Navy not to build them at all.

Engineering News, June 23, 1898.

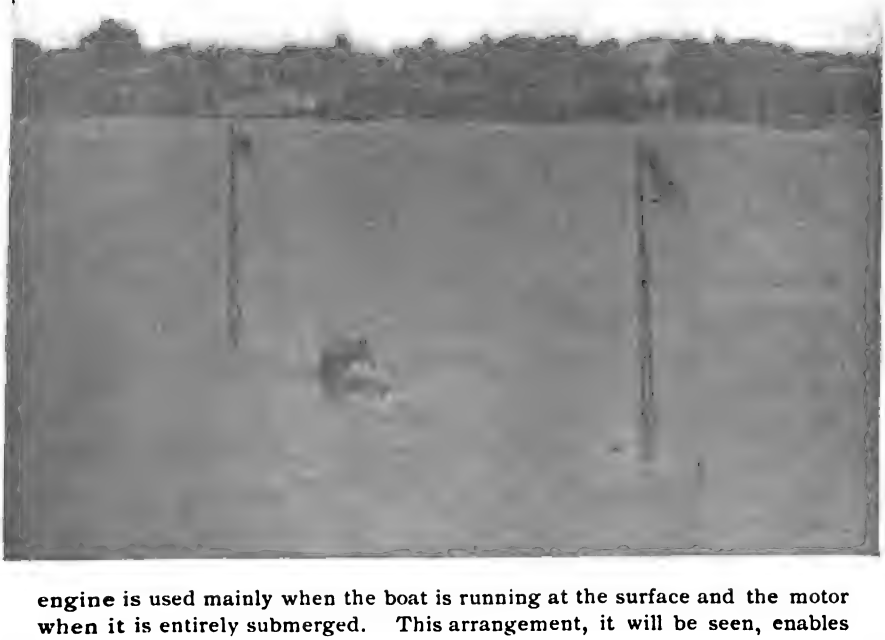
Successful Trials of the Holland Submarine Boat.

Extraordinary interest attaches to the trials of the Holland Submarine torpedo boat which are now being carried out in New York Harbor, and it gives us much pleasure to state that the results thus far achieved have been very satisfactory. By the courtesy of Mr. John P. Holland, the inventor, our photographer accompanied the boat on her trial runs and secured the photographs which are herewith reproduced. In one of these the little boat is shown at her moorings beside the pier; another was taken when she was running at the surface, with only her conning tower above the water; a third view, herhaps the most striking of all, was taken when the boat was diving, and another view shows the stern torpedo gun and the tail-piece for protecting the rudders. These external views are supplanted by a longitudinal section which shows the construction and leading details of the interior.

The Holland submarine boat embodies the results of some twenty years of experimental work by the designer, who firmly believes that this type is destined to become the most deadly weapon of future naval warfare. This is the first submarine boat of its type ever built and tested. Another and larger boat of the kind is now under construction for the Government, at Baltimore, and is practically completed: but the progress upon it was so slow that Mr. Holland determined to build at once a smaller vessel for use in harbor defense. The Government vessel was described and illustrated in the Scientific American, of April 25th, 1896. She is a cigar-shaped boat 85ft. long, 11½ft. in diameter and capable of 16 knots speed on the surface and 10 knots when submerged. Her displacement is 168 tons.

The "Holland" (as she is called) is much smaller, being only 55ft. long, 10½ feet in diameter and of 75 tons displacement. The steel hull is cigar-shaped

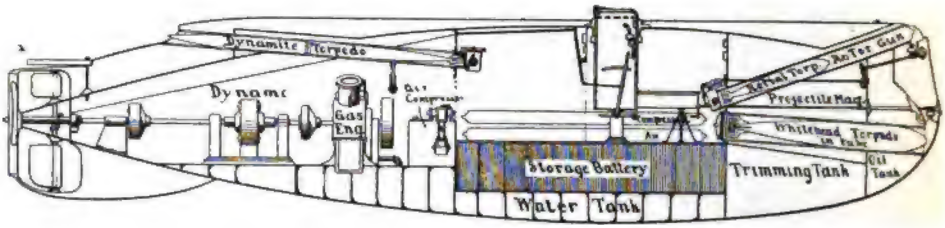
and apporximates somewhat to the model of the Whitehead fish torpedo, being blunter at the head than the tail. Two sources of motive power are furnished. A gas engine is used at the surface and a motor run by storage batteries when the boat is submerged. The storage batteries, which are of great weight, are located amidships, down below the surface of the boat and as their center of gravity comes well below the center of buoyancy of the hull the boat is kept at all times on an even keel. Above the storage batteries on each side of the ship are located the compressed air tanks, from which air is supplied to the crew when the boat is submerged. The motive power is furnished by a gas engine and an electric motor, both of which operate a common shaft, the gas engine being located just ahead of the motor. The gas



engine is used mainly when the boat is running at the surface and the motor when it is entirely submerged. This arrangement, it will be seen, enables the motor to be utilized as a generator for charging the batteries.

The cellular bottom of the little vessel is utilized for the storage of the liquid fuel, and here are located the water ballast tanks which assist in trimming and in the operation of diving and rising to the surface. With the tanks filled and all the crew aboard there is a reserve buoyancy of 250 pounds and the boat is caused to sink by altering the pitch of the horizontal diving rudders, the forward motion of the vessel, combined with the downward pitch of the rudders, force her below the surface. She is maintained at the required depth by means of delicate automatic mechanism similar to that used in the automobile torpedo.

The offensive powers of the Holland are, considering her size and method of attack, far greater than those of any other engine of war, whether ashore or afloat. In the first place she carries in her bow or nose an under-water discharge-tube for launching the deadly Whitehead torpedo. Of these she carries several stowed in a suitable chamber. They are automobile, or self-propelling, carrying their own compressed air engines and a storage tank for compressed air. They are shot out of the bow by a small charge of gunpow-



LONGITUDINAL SECTION THROUGH HOLLAND SUBMARINE BOAT.

der, and as they pass from the discharge tube, a catch releases the little engines and starts the propellers. The torpedo then travels with the speed of the fastest torpedo boat for a distance of from 600 to 1000 yards. Automatic steering mechanism keeps the flying vessel at the proper depth and on a wonderfully true course.

In addition to the Whitehead torpedoes, the "Holland" carries two other discharge tubes for firing gun-cotton projectiles. Unlike the one just described which lies in the longitudinal axis of the boat, these are upwardly inclined, one pointing forward and the other aft. The mouths of the tubes terminate at the ends of a kind of superstructure deck which is built up above the cylindrical portion of the boat and carries at the center of its length an armor-plated conning tower. The mouth of each of these tubes is closed by a sliding cover which is operated by means of a worm and pinion controlled by shafts leading into the interior of the vessel. The forward tube is called an aerial torpedo gun. It is capable of throwing a 100-pound guncotton shell a distance of three-quarters of a mile. The other tube, astern, is called an underwater torpedo gun, and it is capable of driving its shell

with accuracy for a distance of 200 yards under water.

When the boat is at the surface of the water, she can be steered by observation through the port holes of the conning tower. When she sinks below the surface, a small tube, carrying at its top an inclined mirror or prism, in the manner of a camera lucida, will throw a picture of the surrounding water

upon a board in the conning tower. The vessel also carries a compass and an automatic gage showing the depth below the surface.

In making an attack upon a ship the "Holland" would advance, with her small and scarcely discernible conning tower above water, until she was in range for the use of her aerial torpedo gun. A shell containing 100 pounds of guncotton would be discharged, and she would at once sink below the surface, to avoid retaliation. At the moment of discharge an ingenious system of compensating weights will automatically admit to the tanks a sufficient amount of water to preserve the trim of the vessel. This is an entirely new device, and the "Holland" is the first submarine boat that has succeeded in

overcoming the difficulty. When the boat has run up a little nearer to the hostile ship, she would discharge one, and if the first missed, two of her torpedoes. In the unlikely event of missing with the bow torpedoes, she would fire her rear torpedo gun at the enemy as it swept by overhead.

Our illustrations were taken during a series of tests which were carried out on March 27, for the benefit of Lieutenant Sargeant of the Naval Auxiliary Board. The work was done in 30 feet of water and gave full satisfaction both to Mr. Holland and the government expert. The first trials consisted of a series of surface runs at a speed of 10 knots, in which the boat showed great maneuvering power, changing her course through 90° with astonishing rapidity. The diving test was made at the same speed, and upon the diving rudder being thrown into position, the boat buried her nose and went down at an angle of 15° with the surface. At a depth of 7ft. as indicated by her flagpoles, she came at an even keel and forward steadily for several hundred yards. An ascent was then made, the boat coming up nose first at the same angle as she decended. The cover of the conning tower was then thrown open and Mr. Holland announced that he would dive completely out of sight.

One of our illustrations was taken just at this moment and shows the inventor in the act of closing the cover. This time she dived completely out of sight, the flagpoles disappearing altogether. No trace of the vessel was visible

until she made her appearance suddenly at a point several hundred yards distant from the point at which the decent was made.

Later a test was made of the bow aerial torpedo gun, and with a reduced air pressure of 600 pounds (as against the full pressure of 2,000 pounds to the square mile) a dummy torpedo was thrown a distance of 500 yards.

Scientific American, April 9, 1898.

BOOK REVIEWS.

Privates' Handbook of Military Courtesy and Guard Duty by Lieutenant Melvin W. Rowell, United States Army. Kansas City, Mo., Hudson-Kimberly Publishing Company. 1898. 50 cents.

The usefulness of this little book will be acknowledged by all who have had any experience in teaching militia or volunteers the ordinary customs of the service as regards saluting and guard duty. It is the first thing the men have to learn as soon as they have exchanged civilian dress for the uniform. The recruits added to the regulars have little difficulty in learning quickly, but the volunteers, suddenly called into service, however anxious to learn, when thrown on their own resources, do not notice the little details required by regulations, and the customs that have sprung up in the army, and they feel that they are at a disadvantage when compared to regulars.

This handbook seeks to guide the soldier so that he may easily acquire the knowledge that will give him confidence in his daily contact with superiors in rank, and in the execution of his guard and other service daties.

Volunteer soldiers often have a natural feeling of respect for those in authority, and are apparently timid, in consequence, simply because they do not know exactly how to show the respect they feel. A sentinel who halts an officer as required by regulations is inclined to apologize until he knows that the officer, however much he may be delayed and incommoded, expects such action on the part of the sentinel as a matter of course, and is only anxious to have the formalities ended as soon as possible. It is the aim and purpose of this work to teach the soldier his everyday duties that give him the feeling that he is doing merely what he is expected to do.

Such a handbook ought to be in the hands of every volunteer soldier; he ought in that case to have no difficulty in doing his duty intelligently, promptly and in full confidence that it is right.

The sixty pages of printed matter comprise remarks on *saluting*, with the hand and with the rifle; the rules of rendering *honors* to colors and to officers, on the march, in camp, and in quarters, indoors and out; and the manual of guard duty for privates, including general and special orders to sentinels, night orders, compliments from sentinels, orders for sentinels in charge of prisoners, and remarks on the duties of the orderly for the commanding officer and the musicians of the guard. The text is illustrated by nine full page drawings.

J. P. W.

Catechismal Edition of the Infantry Drill Regulations, United States Army Extended Order. Prepared by Major Wm. F. Spurgin, 23d Infantry. Kansas Ciiy, Mo.: Hudson-Kimberly Publishing Co. 1898. 50 cents.

The purpose of a book of this kind is indicated in its title, viz: to fix in the mind all the details of the work to which it pertains, in this case the drill regulation on extended order drill, by a series of questions and answers.

The ground is very fully covered by sixty-four pages of questions and

answers, both conforming as closely as is possible to the wording of the text of the drill regulations.

The assistance rendered by such a catechism in committing to memory all the little points of the regulations is undoubted, but the utility of committing to memory the exact answers to a lot of questions that mean little or nothing in themselves is very doubtful. Let us explain a little more fully.

The questions on the whole are pertinent to the subject, and the answers as a rule are facts worth knowing, but there are a number of questions which are intended merely to bring out a point made by the regulations, and these are often meaningless as questions, although the answers may still contain important matter.

For example.

Page 5. *What action will the officers and sergeants take when necessary?*
Page 6. *At what do men in extended order fix their attention?*
Page 17. *With reference to what will care be takeu?*
Page 24. *What should be avoided?*
Page 54. *To accomplish this object, by what should they be "not" separated?*
Page 58. *Of what is advantage taken?*
Page 64. *If the order be to "form in column," what will be understood?*

Now, what we mean is, that, however well one may *know* the drill regulations on extended order, he could not possibly answer such questions unless he remembered the exact words of the text, which in themselves are not at all essential, since the same *idea* may be just as well expressed in other words.

These questions could all be put in a perfectly intelligible form with very little trouble. As they stand they simply mar the pages of what is otherwise a well arranged and useful little book, especially to the National Guard, who have usually more opportunity to study the extended order than to practice it, and in the study of the subject is just where the catechism comes into play, indeed, every officer and soldier will probably find it useful in fixing the essential points in the mind and in correcting errors committed.

We can say for ourselves that we always adopt the analytical method in studying any particular manual or drill regulations, and find it of great assistance, and the present volume saves us all the trouble of making such an analysis for ourselves. We, therefore, heartily recommend the booklet to all who have to acquire familiarity with the extended order in a comparatively short time, and who desire to know it *thoronghly*.

J. P. W.

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Abbreviations employed in index are added here in brackets.

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CEUTA.*

Ceuta is situated in the north temperate zone, on the northwestern coast of Africa opposite Gibraltar, in latitude 36° N., and longitude 5° W. from Greenwich, and 10° 30′ west from Madrid. It is bounded on the north, east and south by the Strait of Gibraltar.

The city is built on the extremity of a promontory belonging to the African continent, surrounded on all sides by water, a canal cutting off the promontory from the mainland, and making it an island. Including the city and penitentiary, the district has a population of 12,804 inhabitants.

The climate is mild and healthy. The mean temperature is 63.5° F. in autumn, 45.5° in winter, 59° in spring, and 108.5° in summer. The principal diseases are those affecting the skin and the lymphatic system. The easterly and westerly winds which blow annually with great force sweep away most of the diseases which are common to the Iberian peninsula.

The soil of Ceuta is fertile; its base consists of cemented rock, clay, and compact lime containing some silica and rare layers of maritime organic matter.

Public instruction is carried on in colleges belonging to the Provincial Institute, military academies, and schools, the expenses of which are borne by the district, and also many private ones.

The government of Ceuta is peculiar. It is a Spanish city, situated on the territory of Morroco, and is a fortress and a penal colony. Its military organization is immediately subordinate to the Ministry of War, and its jurisdiction belongs exclusively to the Supreme Court of the Army and Navy. All ecclesiastical matters are referred to the Bishop of Cadiz; finances are

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in charge of the Delegation of Finance of the above named province; the Civil Administration also devolves upon the province, while the Municipal Tribunal is subordinate to the Court of Sevilla.

It appears, according to historical data, that Ceuta was one of the earliest colonies founded by the Phoenicians on the coast of Africa and Spain; it was conquered by the Carthagenians, improved by the Roman genius, and finally fell under the sway of the Arabs. In 1416 it was conquered by the King Don Juan I of Portugal. In 1580 it was ceded to the Crown of Castile, and has ever since remained in the hands of the Spaniards. The title of "EVER NOBLE, LOYAL, AND MOST FAITHFUL" has been conferred upon the city by the kings of Spain, in addition to several other privileges.

Ceuta, being completely detached from the mainland, and having no heights commanding the city, except those of Sierra Bullones, and these being at a distance of eight miles from the interior walls, is perfectly impregnable by land. It is impossible to erect batteries, and the heights situated between the city and the Sierra, being fortified and occupied by the Spaniards, puts a land attack quite out of the question.

Ceuta has two bays, extending on either side of the promontory. The southern bay is well sheltered from the northern, western and northwestern winds, while the northern serves as a refuge from the southern, eastern, and southeastern winds.

An insignificient mole is situated in the latter, and a proposition is on foot to construct a military port here. The works in the bays of Ceuta are very insignificant.

Among the land defenses of Ceuta there exist old earth fortifications of the Vauban system, very strong in their time, and not to be despised now. They completely surround the isthmus with two dry passes and a navigable one, supplied with drawbridges, etc., which guard the city from any attack by land.

The following gates in the exterior walls are guarded by night:

At the foot of the battery, "SALA DE ARMAS"	1
At the bridge over the ditch	2
At the head of the bridge	1
At the vault of Cristo	2
At the following vault	1
In the interior or patio of the Angulo	2
At the bridge of the last dry ditch	2
At the fortress gate	1
Total guarded gates	12

At present whenever a Moor wishes to parley with the fortress, he is received at the farthest gate leading to the camp, and conducted with a bandage over his eyes to the palace of the Governor. He is led back in the same way.

The portcullis is also guarded.

There are three military and topographical lines of demarcation in Ceuta, and consequently three fortified precincts.

The first precinct, that of the interior, embraces the whole of Mount Acho, the principal part of which is Punta De La Almina, facing the Punta De Europa of Gibraltar. There are no buildings in this precinct, except the chapel of San Antonio, the Governor's house, and a few very poor dwellings named guintas or casas de campo.

It is impossible to say when the fortification was erected in this important place, and the primary works probably date from the time of the conquest by Don Juan I, King of Portugal. A wall, crossed by a parapet 1½ feet thick, runs along the northern coast as far as the Castillo (fort) De Santa Catalina. Various forts and batteries are distributed along the wall and around the precinct. They are so disposed as to protect each other, and to direct a cross fire upon the neighboring bays and slopes, in case of an attack by sea.

The following are the forts: San Amaro, Torre Mocha, Pino Gordo, El Saucino, Santa Catalina, Punta De La Almina, El Desnarigado, Torrecilla, La Palma, El Guemadero, and El Sarchal.

The second precinct embraces the space between the brow of Mount Acho and the first ditch of the Almina. The fortifications of this precinct consist of the northern wall, completed in 1741, and of the wall and batteries covering the southern line. The city is unassailable from this side on account of the steepness of the escarp running along the coast, and the existence of the northern wall fortifying the base of Mount Acho, thus rendering attack by sea impossible. The following are the batteries of this precinct: San Sebastian, San Pedro El Alto, Los Abastos, Escuela Practica, Pastillo Nucoo, El Molino, San Jeronimo, Fuente Caballos, San Carlos, and San Jose.

The city itself has the shape of a trapezoid, and lies in the third precinct.

The predominating system of defenses in these fortifications belongs to the uniform and simple type, such as fortifications for siege artillery have. Forts and high walls, with towers and turrets enclose the whole city, making an impenetrable barrier.

The sea surrounds and defends the northern and southern coast, while the two main walls which cover the Almina and the continent, are reinforced by wide and deep ditches communicating with the Mediterranean, and giving free passage to vessels of small tonnage.

The following are the fortifications of Ceuta at the present time. From the west coast and the Almina are walls with the following batteries and forts: Sala De Armas, San Juan De Dios, San Francisco El Alto, La Brecha, Espigon De La Rivera, Primera Puerta, El Albacar or Segundo Puerto, Baberte and Tarreon De La Bandora, Cortina De La Muralla Real, Baluarte and Torreon De La Coraza, and Coraza Baja.

The ancient walls are reenforced by two bastioned fronts. The one facing the frontier is 275 rods long, while the other forming the western extremity of the northern defenses is 123 rods long. Two tall towers situated to the right and left of the main line of these fortifications serve as cavaliers to the respective bastions. At a distance of about 80 rods from the counter scarp of the navigable ditch which surrounds the city, and parallel to the first of the two parts; the Valenciana with its fausse-braye and ravelin, built in seventeenth century style, and this, as well as the middle bastions of the new front is covered by two large counter guards, which extend from 100 to 150 yards beyond their flanking angles.

The right counterguard Santiago, reenforced by a cavalier, extends as far as the coast on account of the terrain widening towards the north. Its position is such as to give it a range of fire of 225 rods. This range being considered defective, the fortification is continued so as to cover the middle bastion of San Pedro, and the ravelin of San Pablo occupies the remaining space. The ordinary covert-way joins these defenses.

There are no defenses dominating the undulations of the terrain on the slope where they are erected, but forts San Antonio and San Jorge, and the three lunettes of San Felipe, La Reina, and San Luis, under construction, will form the exterior line of the fortress.

There is a covert-way joining these works which may replace that of the preceding ones, it being in good condition, save only in the part corresponding to the counterguard of San Javier, and the ravelin of San Ignacio. On the capital of the forts and lunettes, and at certain distances on projections of the covert-way were semi-circular rows of fortifications, bearing the number of the fort or lunette to which it belongs.

On the exterior line, the breakwaters Africa and La Ribera are being constructed; the former of the counterguard of Santiago, and the second of the middle bastion of La Coraza, both advancing into the sea, guarding the passage to the right and left, and covering the coast to the north and south of the position.

Lastly, the fausse-braye of the Valenciana has been changed into a terrace, with two small flanks joining the arillons of the front.

The Muralla Real dominates the exterior walls, and the ravelin of San Ignacio is elevated enough to cover its terreplein.

A subterranean defense is also being prepared, which will highly increase the military value of Ceuta.

THE BATTERY OF SALA DE ARMAS.

This battery is situated at the junction of the fortification which is nearest to the navigable ditch, and is composed of the following forts: San Pedro El Bajo, Santa Ana, Tenazon De La Valenciana, Rebellin De San Pablo, Rebellin De San Ignacio, Espigon De Africa, Contraguardia De Santiago and a Cavalier, Contraguardia De San Javier, Fuerte De San Antonio, lunettes of San Felipe, La Reina, and San Luis, and the Fuerte San Jorge. More or less artillery can be located in these forts, excepting that of San Jorge, and the Cortina Del Tenazon. Some of these fortifications, as the Espigon De Africa, the lunettes De La Reina and San Felipe have under their terrepleins galleries of embattled escarps; others, like the Muralla Real, and the counterguards of San Javier and of Santiago have spacious vaults for the accomodation of troops.

The third precinct communicates with the Sala De Armas by means of the first gate situated in the middle of the curtain of the small front leading from the drawbridge to another permanent bridge over the water ditch. Leaving the counter-escarpment at the height of the middle of the right surface of the Baluarte De La Bandera, is a parapet of solid construction, with merlons and embrazures (erected with the double purpose of covering the northern coast and part of the gorge of the front of the Valenciana) in which is cut the second gate. The spacious court comprised between these two gates is named Plaza De Albacar. Passing thence to the ditches of the Valenciana, through the vaults traversing the center of the curtain and the tenaille, or through those situated on its flanks, one meets successively the communications of the exterior works, consisting of glacis, some with bomb-proof covering, up to their issues on

their respective terrepleins, others completely uncovered, and only protected at their entrance by vaults.

The lunettes of San Luis and La Reina have also subterranean galleries of communication, beginning in the passes of San Javier and San Ignacio.

The drawbridges of San Luis and San Felipe, and the postern below the fasse of La Reina at the entrance of the Plaza de Armas give passage to the exterior covert-way in which are entrances guarded by simple portculli; there is another opening upon the northern coast in the ditch of Santiago, defended by a drum opening into that of San Antonio. The galleries open into camp, facing the line of fortifications, and are guarded by iron portculli. They communicate with the coast by means of subterranean galleries of which those of San Luis and of San Antonio open at the foot of the ditches, and the others upon the entrances of the corresponding covert-way of the exterior works.

THE FORTRESS OF ACHO.

The fortress of Del Acho is undoubtedly one of the finest fortresses of Eurcpe. Its lunettes are all bomb-proof, and on the Atalaya are posts of observation commanding both bays.

The plan of the fortress shows that it is built with profound knowledge of the requirements of land and sea defenses.

Its embattled walls, the forts crossing it every direction, the position of its lines of defense; everything denotes that the Acho can be the last bulwark of the defenses of the city in case of great necessity. A company of infantry, and the corresponding formation of artillery find ample room in the fort, which also contains dormitories for 400 or 500 animals.

THE BOUNDARY LINE.

The key to this line, forming the exterior encampment of the city is El Serrallo, the principal quarters where 500 men and two guns are located. Its dependencies are: the port of Principe Alfonso, with 300 men and two guns of 10 centimeters; the tower fort of Isabel II, containing 60 soldiers and 2 guns of 8 and 12 centimeters; the turrets of Einies, Francisco De Assiz, El Renegado, Gebel Anghera, Mendzabal, and Aranguren, in each of which 30-40 squares may be formed; and lastly the tower fort of Benzu, in which 100 soldiers are quartered. This tower, which advances into the sea, dominates by its position the bay of the same name, and is the most important of the fortifications commanding the Maragui territory. It has a gun which, by its position, may be very useful in case of having to oppose the

passage of a suspicious looking vessel cruising in the strait. The guns of the fort of Benzu may some day cross their fire with those of the fortifications and batteries that are being erected on the coast of Tarifa.

The boundary line renders Ceuta impregnable from the land. The military organization of this line of pits is admirable; the soldier is always on a war footing, and the chief of the whole is the commander of battalion detailed from the detachment residing in the Serrallo, and is responsible for everything that may take place in the exterior camp.

All the forts communicate with each other by means of the telephone. From the Serrallo a telephone wire goes to the Fortaleza Del Angulo, principal strategic point of the first precinct. It has a direct communication with the Commanding General, who communicates directly with the Terrallo.

The guns belong to the best systems of Krupp and Ordonez, and are ot the largest caliber known. They are placed by twos in batteries, and their position is such as to cover the whole coast, and give mutual support to each other. The number of the large and small caliber guns is great, and more very small caliber guns, rapid firiug and machine guns will be added.

The batteries are invisible from without, as only the natural talus (rampart) can be seen. All of them contain magnificent casemates, protected by bomb-proof walls, where the troops may find shelter; the ammunition stores and powder magazines are likewise constructed of bomb-proof material, and are perfectly covered from the hostile fire. There are also splendid subterranean fortifications.

Among the batteries there are four with 8 large caliber guns and six auxiliary Krupp guns of 20-30.06 centimeters defending the northern and southern bays. They are the following: Valdeaguas, Torremocha, Pintar and Santa Negra (Puntilla).

There are 11 batteries of howitzers, with a firing elevation of 21 centimeters, in the following strategic points: The Acho (north and south), San Antonio, Obispo, Sala de Armas and Cuatro Caminas (all these in the north).

There are batteries of 12 rifled iron guns, strengthened by rings, of 15 centimeters caliber, in San Jose, San Carlos, and Guemadero (all in the south). In the Muralla Real there are various smooth bore bronze guns, which are going to be replaced by modern ones.

The battery at Valeaguas is surrounded by an embattled wall capable of giving shelter to a great number of combatants, and

of being armed by a number of small caliber rapid-firing guns that may be utilized in case of disembarkation of hostile troops. The Torremocha, Pintar, and Punta Negra offer equal advantages.

King Alfonso XII. was presented by Krupp with a complete field battery of 7 centimeter guns, which was sent to the military park of Ceuta. The circumference of the city is from 7 to 8 miles.

THE MILITARY FORCES.

The garrison of Ceuta is composed of 2 complete regiments of infantry of the line, 1 battalion of artillery, the squadron of chasseurs of Africa, the compania de Mar, and that of the Moorish sharpshooters del Rif, commanded by Spanish officers. The Corps of Engineers is represented by the General Staff, forming the General Command, composed of 1 colonel, 1 lieutenant colonel, 1 commander, 1 captain, 1 other captain in permanent detail, 1 lieutenant, and officers in charge of heliographic communication between the fortress and Algeciras. The military administration employs also a section of workmen. Military health administration has another; each of these companies is commanded by a sergeant and both are subordinate to their respective Chiefs of the Indendency and of the military hospital.

ORGANIZATIONS.	FIELD AND OTHER OFFICERS.											ASSIMILATED.															Enlisted Men.	Animals and Material.			
												Surgeons.		Chaplains.			Veterinarians.			Professors of Equitation.			Officials.							
	Generals of Division.	Generals of Brigade.	Colonels.	Lieutenant Colonels.	Majors.	Captains.	1st Lieutenants.	1st Lieutenants of Reserve.	2d Lieutenants.	2d Lieutenants of Reserve.	Supernumerary 2nd Lieutenants.	First.	Second.	First.	Second.	Third.	First.	Second.	Third.	First.	Second.	Third.	First Class.	Second Class.	Third Class.		Animals, Saddle Horses.	Guns, Approximate.	Launches.	Longboats.
General Staff.	1	1	4	3	8	9	2	1	1			1	2										2	2	6					
African Inf. Reg. No. 2.			1	2	3	13	1	3	9	1	23		1			1										1206				
African Inf. Reg No. 3.			1	2	3	13	2	1	35				1			1										1206				
3d Battn. of Artillery.			1	1	8	8							1		1											376		99		
Squadron of Chasseurs.					1					2								1			1					60	58			
Vol. Militia of Ceuta.				1	1																					59				
Compania de Mar.						1																				59			3	4
Moorish Sharpshooters.						1		1		1																150	130			
Mountain Section.						1			1																	(?)				
Total.	1	1	7	9	24	46	5	6	46	4	23	1	5		1	2		1			1		2	2	6	3116	188	99	3	4

THE WORK OF THE ENGINEERS IN THE SANTIAGO CAMPAIGN.

By Eduardo J. Chibas, Assoc. M. Am. Soc. C. E., late Assistant Engineer to the Chief Engineer of the Fifth Army Corps.

Reprinted from Engineering News, October 13, 1898.

(With maps showing the position of troops at Santiago.)

The echo of heavy cannonading from our war ships—which from early dawn had taken their position in front of Daiquiri—had hardly died away, and clouds of smoke were still hanging here and there over the landscape, when the advance guard of the Fifth Army Corps landed on Cuban soil on June 22 without any opposition from the enemy. Among the transports near shore waiting for orders to unload her troops was the steamship "Alamo," with the Fifth Army Corps' Battalion of Engineers, which was composed of two companies of the U. S. Engineer Corps of the regular army—Company C and Company E of 100 men each. The latter company started from West Point for Tampa on April 30, and the former went from Willett's Point on May 14. Both companies were organized into a battalion in Tampa under the command of Capt. Jas. L. Lusk, who was relieved before the sailing of the expedition by Capt. Edward Burr, afterwards Lieut-Colonel of the Second Volunteer Regiment of Engineers. The officers of Company E were Capt. Edward Burr, First Lieut. E. E. Winslow, now Captain, and Second-Lieutenants H. B. Ferguson and L. Brown. The officers of Company C were Capt. G. D. Fitch, afterwards Major of Volunteer Engineers, Lieut. T. H. Rees, now Captain, and Second-Lieutenants G. M. Hoffman and S. A. Cheney.

On board the "Alamo" were stowed a large amount of square timber of various sizes, 12 pontoons and 15 completed trestles, susceptible of adjustment to any height from 3 to 12 ft. for military bridges; and all the tools and material that any possible emergency might have called into requisition. All the contingencies that might arise had been considered in Tampa, before sailing, and under the personal supervision of Brigadier-General William Ludlow, Chief Engineer of the Army in the field, all the necessary material had been provided. Through his efforts also, many photographs of the Spanish blockhouses and forts had been secured.

The work performed by the engineers in the Santiago campaign may be subdivided into "Reconnoissance," "Piers," and "Road and Bridge Work."

RECONNOISSANCE.

On the morning of June 22, shortly after the first troops had landed, Lieutenants G. M. Hoffman and S. A. Cheney, with four men each, were detached from the Engineer Corps for reconnoissance work under Lieut.-Colonel Geo. McC. Derby, Chief Engineer Fifth Army Corps. They followed close to the advance, taking topography and mapping roads and foot-paths, noting their condition with reference to the transportation of artillery and supplies. They reached the Siboney landing, six miles away, on the next day. The two parties had kept separate, doing work along different roads. They reported every evening to the Chief Engineer's office at headquarters—which for the first week were kept on board the steamer *Seguranca*, that lay first in Daiquiri and then in Siboney Bay. After the troops passed beyond Las Guasimas, three miles from Siboney on the road to Santiago, where the first skirmish of the war was fought by the Cavalry Division, on June 24, four line officers were added to the reconnoisance party under orders of Major William D. Beach, Division Engineer of the Cavalry Division, through whom they reported to Lieutenant-Colonel Derby, Chief Engineer of the Fifth Army Corps. These line officers were Lieutenant Guy H. B. Smith and Lieutenant D. P. Cordray, of the infantry, and Lieutenants G. P. White and M. A. Batson, of the cavalry. After July 3 they reported direct to the Chief Engineer. During the six days of rest and preparation that followed the first battle, and while the troops were camped on either side of the road to Santiago, the reconnoisance party kept constantly at work, very often venturing considerably beyond our outposts and going into the very heart of the enemy's country. The quiet and unostentatious manner in which the work was performed failed to bring it into general notice, and very little has been known by outsiders of the many risks incurred by individual members of the party, and of the commendable and valuable services rendered by them. After looking back over the excellent work accomplished by that small number of men, the only regret is that a much larger party was not placed in the field so that it could have covered the whole country around Santiago before July 1. The information we started with was very meager, as the Spanish government has never made a topographical map of Cuba, and the maps we had

for reference showed merely a general outtine without topographical features.

On June 27, when the American outposts were located at La Redonda, near where General Shafter established his headquarters three days later, and the Cuban outposts were a mile farther on the road to Santiago at El Poso, Lieut.-Colonel Derby and Lieut. Hoffman pushed the reconnoissance work half a mile beyond on the same road.

On June 28, Lieut. Hoffman went three-quarters of a mile beyond the outposts on the road to Caney, and Lieutenants Batson and Smith, from another direction, approached within a mile of the forts around that village.

The writer, on that morning, was ordered to measure a base line and make triangulations at the front to find distances to the City of Santiago, and to locate the prominent points of the surrounding topography. The positions we were able to secure on the hills near our outposts were not advantageous enough for the purposes intended, and on the next day, after having secured an additional force through Major Beach, Engineer of the Cavalry Division, we ventured with Lieut. Batson to within less than a mile of Caney and close to the road connecting it with Santiago. Without the use of field glasses we could see the Spanish sentitels pacing back and forth in front of some of their block-houses. The other members of our party, on that day, were Mr. E. M. Bane, official photographer, one sergeant and two Cuban privates, and one sergeant and five privates of the Ninth Dismounted Cavalry. A peculiar incident of the day was that, without firing a shot we returned to our lines after our work had been performed, with ten prisoners and a horse, captured by our small force. It is fair to explain, however, that they were not soldiers, but civilians, who claimed they had come out of the city to get mangoes and other fruits, and were on their way back to Santiago when we detained them. From them we obtained information as to the number of Spanish troops in Santiago, their condition and the nature of the barbed wire entanglement around the city. On that same day, Lieut.-Colonel Derby and Lieut. Hoffman had gone scouting with a detachment of six Cubans beyond El Poso and almost to the San Juan River crossing, Later on, they proceeded to Marianage, which the Spaniards had evacuated the day before, and climbing a tree they observed the Spanish position on San Juan hill. On June 30, Lieut. Cheney had completed his reconnoisiance along the coast line, and venturing within sight of the Spanish sentinels of Aguadores, reconnoitered

their strong position. On that same day Lieut.-Colonel Derby continued reconnoitering the country towards San Juan and went again far beyond our outposts.

On July 1, Lieut.-Colonel Derby, Chief Engineer, and Lieut. Maxfield, of the Signal Corps, made their balloon ascension, which has been so much criticised. The opponents of the balloon claim that its presence at the front betrayed the position of the troops, and that the deadly fire poured upon it by the Spaniards was the cause of unnecessary casualties. On the other hand, the observers in the balloon, who certainly deserve credit for their unflinching valor while exposed to a most severe fire, argue that their discovery of the trail running parallel and to the left of the main road, through which General Kent swung his division as soon as Colonel Derby notified him of its existence, saved many lives by relieving the congestion of the main road through which the troops had been advancing. The results proved, however, that the usefulness of the balloon in warfare must be confined to the rear, or far enough from the enemy to insure it a fair chance of escape from the fire that will be directed against it, while it must be kept far enough from the main body of the troops to prevent the spent bullets from causing losses that might be avoided.

While the fighting was going on, nearly all the officers attached to the reconnoissance party were out with the troops at either Caney or San Juan in the line of fire, noting the position of the different regiments and brigades.

The instruments used in the reconnoissance work were the prismatic compass, cavaly sketching case, and often a hand level. The distances were estimated by pacing. The average daily distance covered by each individual varied, according to the nature of the country and the width of the belt sketched, from one to ten miles. The different parties reported every evening to the office of the Chief Engineer where the works were compiled, fitted together, and added to the map of the previous day. A tracing was made, and then blue-prints were issued to the commanders of divisions, brigades and batteries, and other officers as far as the available number would permit. The first blue-print issued in the field was on July 3, and they continued to be issued from that time on nearly every other day, showing all additional information and changes in the position of the troops.

The Chief Engineer's office was moved from the *Seguranca* to headquarters in the field, on June 30; but soon after the capture of San Juan, the office was moved to San Juan hill, just behind

our intrenchments for convenience in receiving the daily reports. The mapping and all the field office work was performed by Lieut. Geo. M. Hoffman, of the Corps of Engineers, and the writer, or by either one of them when the other was in the field. Mr. R. S. Porro had charge of the compiling on board the *Seguranca*, and continued attached to the office of the Engineer Corps till July 8, when he was transferred to another branch of the service.

The blue-printing was done by means of an improvised field outfit, as the glass of the blue-printing frame was broken while being unloaded at Siboney, and we were unable to secure another one of the same size to replace it. We were fortunate enough, however, to find two pieces of window-glass about 24 × 30 ins. each. Our improvised frame consisted of the cover of one of the packing boxes around headquarters, over which was stretched a blanket folded to make three or four thicknesses. The blue-print paper and the tracing were unrolled, placed on the blanket and kept in contact by the weight of the two pieces of glass resting on it. For a tray for washing the blue-prints, we used a rubber blanket.

The trenches in the Santiago campaign were not laid out by the engineers, but were dug on the nights of July 1 and 2 by the troops of the line under the direction of their own officers. After the capture of San Juan hill, however, a line officer from each brigade was appointed as Brigade Engineer, under the direct orders from Lieut.-Colonel Geo. McC. Derby, Chief Engineer, and his duty was to look after the trenches and to report daily to the Chief Engineer's office, through one of the members of the reconnaissance party, the changes in his own line of intrenchments, or any changes or extensions he might have observed in the enemy's positions. Some of the trenches that were hastily thrown during the nights of the first and second of July, were improved later on by orders of the Chief Engineers, and a few had to be changed so as to place them on the military crest, that is, the point from which the defender can sweep with his fire the whole line over which the enemy must advance.

PIERS.

On the morning of the first landing at Daiquiri, the engineer battalion was ordered to put ashore a large quantity of intrenchment tools, which were afterwards distributed to the troops of the line; also pontoon material and sufficient lumber to repair the small pier that had been partially burned by the fire started by the Spanish forces as they evacuated the place in the early

morning. The damage had been mostly confined to the approaches, and before midnight the repairing was ended. On the next day the main portion of the engineer battalion, under the direction of Brigadier General William Ludlow, was ordered to proceed on the *Alamo* to Aserradero, twenty miles west of Santiago, to build a temporary pier to facilitate the embarkation of the Cuban forces, under General Calixto Garcia, which were to be transferred to the eastward to co-operate with the American forces. The wharf built at Aserradero consisted of two rows of piles of 5 x 5-in. timber driven by a heavy wooden maul 8 ft. apart longitudinally, and 4 ft. between the rows. The caps were spiked to the side of the pile, to do away with the labor of leveling and cutting them off, and on them rested the flooring of three or four planks.

On June 25, the 3,000 Cuban troops were transferred from the landing at Aserradero, to the three transports, about a mile away, by means of twelve large ship-boats and two navy launches. On the next morning we arrived at Siboney, and the battalion was immediately ordered to proceed to the building of a boat landing at that place. Before dark the work had been completed. The landing consisted of a crib 7 x 7 ft., sunk in 6 ft. of water, and connected with the shore by an approach 45 ft. long. On that day Brig. Gen. Wm. Ludlow, now Major Gen. U. S. Vol., was detached from the Engineer Corps and given active command of troops in the field; the 1st Brigade of the 2nd Division. A portion of the battalion was detailed to begin work on a much larger pier from June 27 to July 1, when the whole battalion was ordered to the front and did not return to Siboney to resume its work till July 5. This pier consisted of three cribs. The first one was 10 ft. square, built of 5 x 12-in. timber, and sunk 30 ft. from the shore in three or four feet of water. This portion of the approaches was finished about July 1, and began to be used shortly afterwards. The next two cribs, one of which was built by the 33d Volunteer Michigan Regiment while the battalion was at the front, were built of 12 x 12 in. timber. They measured 30 ft. deep and 10 ft. wide, and were sunk in 6 and 10 ft. of water, respectively. The spans between the cribs were 15 ft., making the total length of the pier about 130 ft. It was completed on July 12 after many difficulties, due to the heavy surf constantly beating against the shore, had been encountered and overcome.

ROAD AND BRIDGE WORK.

The portion of the battalion which was not detailed for the

pier construction worked on the road from June 27 to July 1, when both sections were combined, and, as before stated, were ordered to the front. On July 2 the whole battalion worked all day under fire, improving the road near the crossings of the San Juan and Aquadores Rivers, and rendering those fords passable by wagons. On the next day, July 3, the battalion was marched to Sevilla, and on that day and the succeeding one they worked on the road from there to Siboney, where they went to resume the pier work. At that time Lieut. Brown was detached from the battalion and placed in charge of road repairng. Under his orders he was authorized to draw details of two battalions, or about 600 men, from Division Commanders. These details were generally taken from the volunteer regiments, and many men from the 71st New York were assigned to this work. These men made wide clearings on both sides of the road to allow the sun's rays to penetrate and dry the road beds. They corduroyed the swampy portions, improved the drainage, and opened up new roads on either side of the old road, along portions which had been rendered impassable, and extended them so that all portions of the line along which the besieging army was located could be reached by pack mules or wagons. These men also built some bridges and culverts, using such material as was at hand, which was often bad and difficult to procure. Lumber from the landing could not be had on account of lack of transportation.

After the surrender the Battalion of Engineers continued at work until August 16. From July 19 to July 22 they repaired the Aquadores railroad bridge, one of whose piers and the two spans resting on it had been blown up by the Spaniards. The completion of this work allowed the trains to run from Siboney to Santiago Harbor. Later they repaired portions of the railway from Santiago to San Louis that had been partly destroyed; rebuilt about 300 ft. of a high trestle over Purgatorio Creek, which had been partially burned, and a smaller bridge near Boniato that had also been damaged.

GENERAL REMARKS.

The Engineer Corps has been widely criticised for not doing work that they were expected to do during the Santiago campaign; but the critics certainly ignore the difficulties under which the Battalion had to labor, not difficulties of nature, which they were fully able and prepared to meet, but difficulties arising from the peculiar manner in which the campaign was conducted. Had

the Engineers been furnished with two or three wagons to transport to the front some of the material that was safely stowed in the hold of the S. S. *Alamo*, while she rode on the waves in front of Siboney, they could have bridged every single ford in a short time. They could have improved many portions of the road, and its carrying capacity would have been greatly increased. But the Engineers were dependent on other Departments for transportation which they could not secure. They had three wagons for their own use while camping in Port Tampa, and although, I understand, they asked to be allowed to take them with them to Cuba, their request was refused.

The Battalion of Engineers is equipped and drilled as Infantry. The enlisted men in it are trained and drilled as infantrymen, and besides have special drills in building pontoons and military bridges ; in laying out and building fortifications ; in sapping and mining ; in planting and operating submarine mines, etc., and although they accomplished a great deal at Santiago with the means at their command, they were certainly fit to perform a much greater service than they were given a chance to perform.

In conclusion, it may not be out of place to refer to what was one of the most impressive lessons of the campaign, to every intelligent observer, that our troops were under great disadvantage on account of their use of black powder. Whenever our cannons and small arms poured forth their shots such a dense cloud of smoke hung around them as to furnish an excellent target for the enemy. On the other hand, when the Spaniards fired it was almost impossible to detect their position, and it was only after considerable watching on our part that their artillery could be located at all.

NOTE.

The following corrections and additions have been made by Major General Ludlow, U. S. A., on the map herewith published in connection with "The Work of the Engineers in the Santiago Campaign:"—

On the first map, showing conditions on July 1st, the position of the 2nd Bat., 22nd Infantry, at Caney, is changed to a point on the road leading from Caney to San Miguel. The camp of the 1st Brigade, 2nd Division, on June 30th, is also shown on the Siboney road, at the south tributary to the Rio Seco, just east of La Reconda.

On the map of July 14th, the following additions are made: The headquarters of the Cuban General Sanchez are shown at Dos Caminos, on the Cobre Road, leading out of Santiago, and his troops occupied the point on this road marked "Cemetery."

General Ludlow also indicates the four successive positions occupied by the 1st Brigade, 2nd Division, on the dates named, as follows: (1) July 2nd and 3rd, at San Juan Hill; (2) July 4th to 7th, near position on map marked by "Light U. S. Battery, 4 guns, Col. Theaker"; (3) July 8th to 10th at positions marked "12 I., field battery, 7 I."; (4) July 11th and August 13th, northwest of Santiago, with right wing resting on the "Cemetery" and left wing extending to and including the 2nd Mass. Regt.—*Ed.*

REPORT ON THE FRENCH GRAND MANEUVERS OF 1897.

BY

First Lieutenant JOHN R. WILLIAMS, 3rd Artillery, Military Attaché, Berne.

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THE THEATER.

The theater of the Grand Maneuvers of this year was the region in the north of France between Arras and St. Quentin, lying partly in the 1st corps region and partly in the 2nd corps region.

The 1st corps region comprises the Departments of the Nord and the Pas de Calais, with headquarters at Lille. The boundary of this region to the north is the Belgian frontier, its western boundary, the Straits of Dover, called by the French, "Le Pas de Calais."

The 2nd corps occupies the territory directly to the south of the 1st corps. Its region comprises the departments of the Aisne, Somme, and Oise, together with a small portion of the Department of Seine-et Oise (Arrondissement de Pontoise), and a portion of the Department of the Seine, including three of the arrondissements of Paris. Its headquarters are at Amiens. It touches the English Channel or "La Manche" on the west.

It was given out last spring that the grand maneuvers of this year would comprise combined military and naval operations in the vicinity of Dunkirk, including the siege of that city. The naval squadron of the north, however, was withdrawn in order to accompany the President of the Republic in his recent visit to Russia, and the co-operation of a naval force being thus rendered uncertain, the plan of the maneuvers was altered and the theater changed so as to include only land operations. The navy, however, was not to remain without representation in the maneuvers. A brigade of marine infantry and three batteries of marine artillery participated in the maneuvers of army against army.

CONDUCT OF OPERATIONS.

The conduct or superior direction of the Grand Maneuvers was intrusted to General de France, the commander of the 1st Army

Corps and member of the Superior War Council of France.* The name of this officer has caused some confusion.

The maneuvres were of two sorts and lasted in all from the 4th of September to the 12th, inclusive, with only one rest day, the 8th. The operations of the first kind were those of corps against corps, the 1st Corps being pitted against the 2nd, each side in addition having a whole division of cavalry attached. These maneuvres commenced September 4th and ended September 7th. The Military Attachés were not invited to witness them. It is not believed that there was anything of a secret or confidential nature connected with these operations, as they were reported with considerable fullness by the daily press, but they were, of course, on account of the small number of troops engaged, of a relatively unimportant character, and not sufficiently interesting to justify the presence of the foreign officers. The themes of the two set of maneuvres, however, were intimately connected, and represent the progressive steps of the repulse of a hostile army which has advanced from the direction of Reims and Laon, and has penetrated beyond the formidable obstacle of the River Somme.

The second series of maneuvres were those of army against army. The 1st and 2nd Corps were united, with the addition of one division of cavalry, to represent the French Army of the North, while the advance of the army of invasion was represented by a provisional corps, and two divisions of cavalry. These grand maneuvres, properly so-called, commenced September 9th and ended September 12th. The 13th was a day of rest for the troops, and on the 14th there was a grand review before the President of the Republic, followed by the dislocation of the troops the following day.

COMPOSITION AND ORGANIZATION.

The composition of the corps d'armée of the French metropolitan army is pretty uniform, and is stated very clearly in Military Information Division pamphlet No. 8. There are, however, in every corps region, a number of units not entering into the composition of the corps proper, but nevertheless subject to the General commanding the Army Corps. Such are battalions of chasseurs or rifles, regiments of regional or garrison infantry, and battalions of fortress or foot artillery. Occasionally marine

* In the State Department translation of the note of Ambassador Patrenotre to Secretary Sherman, dated July 20, 1897, it is stated that the maneuvers will take place under the direction of "the General of France." There is no General of France or General Commanding the Armies of France. A bill is now pending in the French Chambers to establish the grade of General in the Army, but the chances of its becoming a law are not considered good. De France in this case is a proper name, that of the General of Division commanding the 1st Army Corps.

troops are found garrisoned in places away from the seaboard, as is the case in the Military Government of Paris. It was out of such elements, together with a division taken from the 6th Corps, that the Provisional Corps or army of invasion was principally made up.

The "ordre de bataille"* gives most of the details of organization of both sides.

THE MANEUVER STAFFS.

General de France, the Maneuver Director, also commanded the Northern or National Army. As Maneuver Director and Army Commander he had his hands full, so he relinquished the command of the 1st Corps to General Chanoine (one of his division commanders). With some modifications, General Chanoine retained the staff of the 1st Army Corps, while a separate army Staff was organized for General de France, which also discharged the duties of a special maneuver staff.

The Umpire Staff, however, was distinct from the Army Staff. There was an Umpire Director General, who was attached to the headquarters of the Maneuver Director. For the army maneuvers there were organized for the Northern Army four groups of umpires. Each army corps and each division of cavalry, including the Provisional Division, had such a group attached, under a chief of group.

For the Southern Army (Manchons blancs) five groups of umpires were organized, one for the Provisional Army Corps, one for each division of cavalry, and one for each of the infantry divisions composing the Provisional Army Corps. The functions of umpires were performed by general officers and colonels of experience, specially selected for the purpose. Each umpire had attached to him from one to four staff officers as assistants.

The role of the umpire staff was defined to be to keep the Maneuver Director informed of the course of operations and of the incidents which might occur from time to time, leaving, whenever possible, the decisions to be made by the Maneuver Director himself. No body of troops could be neutralized, or ruled out of action, without a decision from the Director himself.

CAVALRY.

One special feature of the Army Maneuvers was the employment of large masses of cavalry. The country between Bapaume and St. Quentin, which was the theater of the Army Maneuvers,

* This expression, used also in the same sense in Germany, does not mean "order of battle" in the English sense. It designates a representation, often tabular or graphical, of the composition and organization of a force or army.

is mostly of a gently rolling character in which in good weather the operations of large masses of cavalry are very easy. The principal obstacles are the streams and hollow roads. Ditches are rare. There are scarcely any fences, except those in the villages and those surrounding the various farmsteads. The hollows between successive ridges are generally deep enough to afford good cover for operations. From the summit of one ridge, it is generally impossible to tell what is going on in the hollow behind the next one.

PROHIBITIONS.

The grain had all been harvested, and large stacks dotted the country in all directions, affording good cover for outposts and small patrols. Immense fields of sugar beets, however, were common, and the orders were to respect them whenever possible. Infantry troops were forbidden to assemble in such fields, though they might cross them by confining themselves to the furrows and country tracks. Cavalry and artillery were forbidden, as a rule, to enter them. In many cases, however, great damage was done to beet fields during combats. In such cases, troops of all arms go pretty much where they please, except that they are always forbidden to enter enclosures and fields where owners have posted signs to keep out troops and intruders of all sorts. Damages caused to crops by unavoidable operations are paid by the government, and are one of the causes of considerable expense in the execution of grand maneuvers each year.

In action opposing bodies of troops are not allowed to approach each other nearer than 100 meters.

Railways must not be crossed except on the intersecting roads.

Bridges are never actually destroyed. A few fascines placed across a bridge indicate that it is supposed to be destroyed. A few men are always left to guard them.

No prisoners are taken during maneuvers. Detachments that have rendered themselves liable to capture may be neutralized for the day.

The trains and the functionaries of the intendence are generally neutralized, and must not be interfered with by either side.

THE BALLOON SERVICE.

The balloon is hardly a novelty in the grand maneuvers, as a balloon section has taken part in them every year for a number of years. So far only one balloon section has been present, and on the rare occasions this year when it showed itself, it was always assigned to the national or northern party. The balloon

used was of the spherical type which appears to have been definitely adopted in the French army, with a car attached capable of carrying two observers. It appeared only on the last day of the grand maneuvers, and though the breeze was hardly what would be called fresh, and the cable wagon remained nearly at the same point all the time the balloon was in the air, yet the oscillations were most pronounced, even at a distance of five miles. On the day of the grand review, the breeze was again at times rather brisk, and the cable wagon towed the balloon along at a walk. About forty meters of cable was paid out, and there were said to be two officers in the car. The balloon ducked and dipped so much that several times it almost touched the ground, and the oscillations of the car were so violent that once what appeared to be a sack of ballast was pitched out, and the two observers must have had great difficulty in avoiding being pitched out at the same time. Finally the balloon was lowered to the ground by reeling in the cable, and the officers in the car got out. When the balloon passed the reviewing stand the car was empty.

THE SHELTER TENT.

The shelter tent was abolished some years ago in the French army, but this year it was introduced again by way of experiment. The numerous villages in the theater of operations allowed the troops on both sides to be cantonned every day, but nevertheless from 60 to 75 tents were issued to each infantry company, and 40 to each battery of artillery, or about one tent to every two men. The infantry and cavalry were enjoined to use the shelter tent on outpost duty, and whenever any unit was forced to bivouac. All troops were also required to be practiced in the use of the tent, whether they utilized it or not. As the troops were never seen in bivouac, it is impossible to say to what extent the tent was really utilized, or how far the experiment was satisfactory. In the infantry the pieces of tent and the various sticks were carried by the men themselves, and never on the wagons, thus adding from two to three pounds to the burden carried by an already overweighted soldiery.

UNIFORM AND ARTICLES CARRIED.

The troops on both sides turned out in "tenue de campagne," or heavy marching order, carrying the full kit, and as has been already mentioned, pieces of the shelter tent in addition. Instead of carrying the overcoat in the pack or kit, this garment is worn by the infantry as the habitual dress, while the dolman, tunic, or other upper garment is carried in the pack. The skirts

of the overcoat are turned back so as not to interfere with marching. Each infantryman carried, in addition, a small bundle of twigs, or a wisp of straw, to aid in kindling a fire when the day's march was over. Even after they had been in the field over a week, the men still carried these bundles of twigs. It is probable, however, that the men, being mostly in cantonments, were not often called upon to light camp fires, and that the same bundle of twigs served throughout the whole of the maneuver. In some cases, it is said, the men were furnished ration money. and could then buy their meals direct from the inhabitants where they were cantonned, without waiting for the trains to arrive and the rations to be issued.

Officers' saddles generally, and also those used by the men in the cavalry and artillery are furnished with an attachment or frog, in which the saber is habitually carried when the man is mounted. As the snap hooks or swivels used for attaching our officer's saber to the slings are constantly breaking or coming unfastened in the field, the practical advantages of the French method of attachment are obvious.

The only differences in uniform on the two sides were the white cap covers, or "manchons," worn by the troops of the Southern Army.

CYCLISTS.

Cyclists for messenger and orderly duties are now a recognized institution in the French army, the service being regulated by the "Règlement du 5 avril, 1895," (copy on file in the Military Information Division). Cyclists are attached for these duties to the staffs of regiments and of some independent battalions, and also to the headquarters of brigades, divisions, corps and armies. Even cavalry brigades and divisions are allotted a certain number of cyclists.

The cyclists seen during maneuvers are said to have been very largely reservists, who are allowed to use their own machines, and consequently several different patterns were represented. Few or none of these regimental or staff cyclists were provided with folding machines, so that when the roads were too heavy for wheeling, they were obliged to go on foot and push their cycles along. In good weather, the cyclists did not confine themselves to the roads, but were seen not infrequently riding across country. Naturally they did not cross cultivated or ploughed fields in this way, but whenever there was turf or reasonably hard ground, the cyclists were able to wheel pretty well off the roads.

At the review, the regimental cyclists followed in rear of their

regiments. While actually marching past, most of them walked and pushed their machines, but some were seen riding when in front of the reviewing stand, keeping their distances very well behind their regiments.

The Cyclist Company.—This is the famous company trained by Captain Gérard, and equipped with the latest type of his folding bicycle. It does not figure in the "ordre de battaille," nor is any mention made of it in any of the orders furnished to the foreign officers. From actual inspection of this company and from reports published in the daily press, it appears to have consisted of about 90 men, who represented a force of about 150. During the Army Maneuvers it was attached to the Northern Army. Divided into two platoons, one on each side, it had already taken part in the maneuvers of corps against corps.

The folding cycle itself, the much-talked of invention of Captain Gérard, is a patented article, which may be examined and purchased by anybody. In the agent's window, No. 68 Avenue de la Grande Armée, Paris, may be seen machines that are said to have been actually used in this year's maneuvers, and there is not the slightest attempt to keep the details of the machine secret. A copy of the agent's pamphlet containing a drawing and description of the latest type of the folding cycle is sent herewith.

ARTILLERY.

With only one or two exceptions, the horse and field artillery entered into the composition of the corps and divisions in the usual proportions. Neither the pieces nor the equipment and harness are new, and accurate descriptions of all the present light artillery matériel of the French army may be found in various official manuals (most of them on file in the Military Information Division). There were no ammunition trains, and no opportunity was therefore offered to see the important question of ammunition supply in the field worked out in all its details.

Most of the batteries took the field with only four guns. The batteries of the 4th Division (2nd Corps), for some unknown reason turned out with six guns. There was one caisson per piece, but on the march and in line of battle only two caissons were with the guns, one to each platoon.* The other caissons and the forges and battery wagons formed a train, which on the march followed in rear of the whole body of the fighting units.

* It is probable, however that some, and perhaps the majority of the field batteries had only one caisson per platoon in all.

In action, the guns were supplied from the two caissons, the teams of which were sent to the rear whenever cover could be obtained for them at a reasonable distance. The piece limbers also sought similar shelter, but remained horsed.

The most striking exception to the regular organization of the artillery occurred in the corps artillery, probably that of the 1st Corps. One group of artillery was made up of batteries of position, armed with the new short piece of 120 mm. caliber. None of the official papers communicated to the press and to the foreign officers gave any indication that any such guns were in the field. Putting together various reports it would appear that there were three of these batteries, of four guns each. Each piece was drawn by six horses, and they seemed to maneuver on ordinary ground with as much facility as the heavy field batteries. On the second day of the grand maneuvers, these guns were seen in line with the other batteries of their corps artillery, and followed the retreating columns of the Southern Army from position to position with apparent facility. On the day of the Grand Review they marched past at the trot, and the ground being perfectly level and quite hard, the gait was easily maintained.

Similar batteries have made their appearance in the German army, the cannoneers being supplied by the foot artillery, and the teams and drivers by the Military Train. It is not certainly known how the French heavy batteries which appeared at the maneuvers were manned and horsed, and it is not impossible that the expedient adopted in Germany was made use of here.* The proper role of this kind of artillery has been much discussed of late, and writers who have dealt with the subject have adopted widely divergent theories. So far as the peace maneuvers indicate, these guns will be used to reinforce the corps artillery with a new and more powerful gun than that of the field batteries. A distinguished Italian writer has maintained, however, that these batteries would be used in future wars as the special weapon of the Commander-in-Chief, to make the final breech in the enemy's line at the moment of the supreme assault. This would be, in effect, a revival of the old "artillery reserve," with somewhat different functions. The views of the writer in question, while they have been widely translated, have not been as generally accepted. The only thing that can be predicted in this regard with probability is that a portion at least of the foot or fortress

* There is good authority for the statement that these batteries belonged to the 27th Regiment of Field Artillery, and that they are additional to the regular organization of this regiment.

artillery will in the next great war be utilized to reinforce the artillery of the line of battle, a real strengthening of the artillery arm without any increase in the actual effectives of the army and with a minimum increase in the military budget.

ENGINEERS.

Each division had an engineer company attached with its train, but there were no engineers attached to the army corps, and no bridge trains were therefore in the field. The water courses of the country were mostly narrow and sluggish, and were traversed by roads sufficiently numerous to dispense with any auxiliary means of crossing streams. Some of the larger streams in the theater of operations ran through wide swampy bottoms, necessitating long causeways to reach the bridges. In these cases, it would have been impossible for heavy vehicles to reach the streams themselves except over the causeways, and no bridges could have been laid had bridge trains been supplied. Besides the divisional companies the only other engineer troops participating in the maneuvers were those attached to the balloon park, already mentioned.

COMMUNICATIONS.

The principal means of communication used were mounted orderlies and cyclists, and the telegraph. Signallists of the line, such as are trained in the United States army for work with the flag, torch and heliostat, are no longer made use of in the French army, except on the frontiers, and to connect fortified places with each other.

The telegraph is made use of in various ways. In the line of the army itself, there is a light telegraph service organized in the cavalry regiments, (six men in each regiment) and each brigade has a 1-horse light telegraph cart attached to its headquarters, In the cavalry divisions, the regimental telegraphists are consolidated into a telegraph section (atelier). The headquarters of a cavalry division has also its light telegraph cart.

None of these cavalry telegraphists were ever seen at work, and the extent to which they were actually utilized is unknown. For the transmission of orders and reports over long distances reliance seemed to be placed on despatches sent over the ordinary telegraph lines of the country, and on what are called Telegraph Sections of the 1st Line.

These sections are composed of practical telegraphers and linemen and are only mobilized for war or for maneuvers. The

chiefs and officers of these sections are civilians, already designated in time of peace. They are not regarded as having the the status of officers, but have a species of assimilated rank. One of these sections was mobilized for the Headquarters of the Army or Maneuver Direction, and one was attached to the headquarters of each of the regular corps. The Provisional Corps was served by a detachment from the section attached to the Maneuver Direction.

These telegraph sections formed, with the telegraph wagons, and the teams and drivers, which latter were supplied by the Military Train, so many telegraph trains. They laid field telegraph lines, took them up and kept them in repair, and furnished telegraphers for the field instruments, in very much the same manner that our Signal Service does.*

MAPS.

In rainy weather a map pouch of some sort is a necessity. The French staff officers were provided with despatch pouches, with a pocket for maps, one side of the pocket being transparent celluloid, so that the map could be read without taking it out of the case. In the rainy weather of the first day's maneuvers, officers not provided with such map pouches had simply to dispense with using their maps. Consequently, before the last day of the maneuvers, nearly all of the foreign officers had provided themselves with map pouches of some kind.† With careful handling, even in good weather, a map used in the ordinary way will go to pieces rapidly, while used in a case, it will last indefinitely.

DISLOCATION.

The dislocation commenced the 15th of September, the day after the grand review. As all the officers and military guests specially invited to witness the maneuvers returned to Paris by special train from Cambrai the evening of the 14th, none of them were present to witness the operations of dislocation. It was reported in the daily papers that there was not much to see, as most of the troops being only two or three marches at most from their stations, the majority of them marched home. A few organizations coming from a distance were, however, sent home by rail. No cavalry was sent by rail, and the only batteries so transported appear to have been those of the Marine Artillery. The station at St. Quentin and three or four smaller stations in

* See Instruction générale sur l'organization et l'exécution du Service de la Télégraphie militaire; Annexe 4 to the "Instruction Générale sur l'Exécution des Maneuvers d'Armée en 1897."

† The Military Information Division has in its possession a sample of a Prussian despatch case, which has a map pouch with transparent celluloid cover.

the vicinity were utilized, and it was reported that the affair was so well managed that the regular trains were scarcely delayed at all.

Ordinary freight cars or "goods wagons" were used for both men and horses. Each car intended for carrying men was provided with enough benches to seat the number to be transported. The cars bore labels indicating the destination and the route. As fast as the trains arrived, the cars were numbered by the sergeants, under the direction of an officer, and the number of men that each car was to carry was also chalked upon it.* The men of the particular organizations were then marched to the siding where the train stood, took their places, and the train moved off.†

OFFICIAL REPORTS.

The official reports to be made out during and after the maneuvers are indicated on pages 5 and 6 of the "Instruction générale sur l'excution des Maneuvers d'Armée en 1897."

None of these reports have been published, nor is it likely that any of them will be. The German General Staff published last year a brief official account of their grand maneuvers of 1896, but nothing of the kind appears to be expected in France. Brief statements of the general and special themes of the maneuvers were communicated to the various journals and to the invited guests, as were also statements, in the form of orders of the day, equally brief, of the situation of the Northern Army at the end of each day, and the movements projected for the next. The "ordre de bataille" of both sides was also made public, and some further information on the organization of the contending armies may be gleaned from the maps and plans showing the disposition of troops for the grand review.

INVITED GUESTS.

The foreign officers invited to attend the maneuvers were requested by the Chief of Staff of the army to repair to the station of the Northern Railway, Paris, the evening of the 7th September, where a special train, put at their disposal by the government, would leave for Cambrai, the point of reunion designated, at 7 o'clock in the evening. Five officers of the French army were detailed to accompany the guests.

With the exception of the two senior officers of the Russian

* Freight cars in France are all permanently marked with the number of men or horses that they can carry, but it is probable that the men were not crowded into the cars as they would be in case of actual moves in war time.

† See "Instruction sur le Service des Chemins de Fer," Annexe 6 to the "Instruction Générale sur l'exécution des Maneuvers d'Armée."

Military Mission, who were lodged at the Sous-Préfecture in Cambrai, all the foreign officers were lodged at the Hotel de France in that city.

The invited guests were taken every day, by rail, to the point nearest the center of operations for the day, where horses and orderlies were in readiness for them. The station from which the train would start on the return to Cambrai and the hour fixed for the departure, were also announced beforehand. The hours of arrival and departure were so chosen as to give the guests from four to five hours for observation. This plan was admirably calculated to assure the comfort of the invited guests, but gave them no opportunity to see the troops at the end of the day's march, or the operations of bivouac, cantonment, etc. When the foreign officers arrived on the ground, in the morning, although the start was often made from Cambrai before 6 a. m., the troops were always found to have been under arms and sometimes to have been on the march during a period of from two to three hours.

The foreign officers were supplied with the official maps of the theater of operations, of various scales, with the general theme and the special hypotheses for both sides at the start, and every evening, each one received an individual copy of the orders of the Commander of the Northern Army for the following day, which usually gave a very brief outline of what had been accomplished during the last twenty-four hours.

The Operations From Day to Day.

SEPTEMBER 8TH.

Day of rest for the troops.

The following themes were received on the evening of the 7th September:

GENERAL THEME OF THE ARMY MANEUVERS.

The maneuvers of Army Corps against Army Corps will terminate on the 7th September.

8th September.—Rest.
9th, 10th, 11th, 12th.—Army Maneuvers.
13th September.—Rest.
14th September.—Review.
15th September.—Dislocation.

HYPOTHESIS FOR THE SOUTHERN ARMY.

Southern Forces: (White cap covers).
- 1st Provisional Army Corps;
  - 12th Inf'y Div'n,
  - Prov. Inf'y Div'n.
    - Marine Brig.,
    - Provis. Brig.
- 1st Cavalry Division;
- 4th Cavalry Division.

1. A Southern Army has seized la Fère and Laon (southeast of St. Quentin, 20 and 40 km.) and has invested Reims.*

2. It is covered on the northwest by two cavalry divisions in position near St. Quentin, and by an Army Corps (two divisions) in position on the left bank of the Oise, towards Ribemont (15 km. southeast of St. Quentin).

3. Informed that an army from the north, assembled to the north of Arras, is on the march towards the southeast, the Commander of the Southern Army orders his covering corps to move in the direction of Arras (70 km. northwest from St. Quentin) for the purpose:

1st.—Of making contact with the Northern Army.

2nd.—Of maneuvering in such a manner as to delay the march of the latter until it (the covering corps) has been reinforced by an army corps drawn from the main body of the besiegers, and sent by forced marches from Neufchâtel-sur-Aisne towards St. Quentin.

The two corps thus united should be able to assume a vigorous offensive, in order to oppose any ulterior operations against the army of investment.

HYPOTHESIS FOR THE NORTHERN ARMY.

Northern forces:
- 1st Army Corps;
- 2nd Army Corps;
- 5th Cavalry Division.

1. A southern army has seized la Fère and Laon and has invested Reims.

2. A northern army, charged with operating against the forces investing Reims, has commenced its march towards the southeast, and has reached the road leading from Arras to Amiens through Acheux.†

3. It has for its first objective the hostile forces reported in observation along the Oise towards Ribemont (s. e. of St. Quentin).

* Reims is not shown on the map. It is some kilometers to s. e. of Laon.

† 30 km. s. w. of Arras.

OPERATIONS.

(General Program.)

First Day.—(9th September). Operations of the cavalry divisions. Cavalry combat.

Advance of the Northern Army and of the Corps of the Southern Army. under the protection of the service of security of the 1st line. Making contact by the advanced guards.

Second day.—(10th September). Combat between the Army of the North and the Corps of the Army of the South.

Third day.—(11th September). The southern corps decamps by a night march, in order to occupy a defensive position prepared to the west of St. Quentin, where it expects to resist until the arrival of reinforcements, or the army corps sent to support it. Advance of the Army of the North in pursuit of the southern corps.

Fourth day.—(12th September). Attack by the Army of the North on the position occupied by the southern corps.*

In conformity to the above general and special themes, the troops composing the two hostile armies spent a portion of the 7th September in getting into their positions as indicated in the themes. The battle of the 7th instant, the concluding feature of the operations of corps against corps, had centered around the village of Mouchy-au-Bois. After the action, the 1st corps retired to the west of Arras, with headquarters at Dainville (4 km. west of Arras). The 2nd corps also crossed the railway from Arras to Doullens, so that the advanced guards occupied the general line: Arras-Beaumetz les-Loges (10 km. s. w. of Arras) Bavincourt.

The 5th cavalry division, which was supposed to be in contact with the enemy's cavalry, and to have been partially repulsed by them, was occupying an extended front from Lagnicourt (19 km. s. e. of Arras) to Vaul-Vraucourt (5 km. west of Lagnicourt). It was supported by the two brigades of corps cavalry, occupying the line Boyelles (10 km. s. of Arras) Hamelincourt-Ablainzeville-Bucquoy (11 km. n. w. of Bapaume).

As for the Southern Army, it was known that a division of cavalry (1st cavalry division) had been encountered in the vicinity of the villages of Haplincourt and Villers-au-Flos. These were very nearly the positions that this division had occupied at the close of the corps maneuvers. The Northern Army had also intelligence of the presence of a second cavalry division

* End of order.

on the Cologne.* This force was the 4th cavalry division, which belongs to the 6th corps region, with headquarters at Sedan. According to the *Figaro*, this division had been maneuvering from the 4th to the 7th September in the region between Marle and Roisel.†

It was announced in orders from the headquarters of the Northern Army, dated September 8th, in the evening, that the enemy's corps reported in observation along the Oise was marching in the direction of St. Quentin.‡

The Southern Army.—With the exception of the special hypothesis for this army and the indications of the general program, no orders and scarcely any indications of the movements of this army were made public. It was known that the 12th Infantry Division, of the 6th Corps Region, had come from the Camp of Châlons, maneuvering in the region of the Suippe ¶ and in the neighborhood of Sissonne. The division commander, General Kessler, who had been appointed to command the Southern forces, had relinquished the command of his division to General Rau, one of his brigade commanders.

The "ordre de bataille" shows the composition of the two armies to have been as follows:

Northern Army:
- Infantry, 50 battalions;
- Cavalry, 10 regiments;
- Artillery, 180 guns.

Southern Army:
- Infantry, 23 battalions; §
- Cavalry, 12 regiments;
- Artillery, 76 guns.

Orders of General de France, evening of September 8.

The orders for the operations of the Northern Army for the 9th of September stated that:

I. The hostile corps in observation on the Oise was in motion toward St. Quentin;

One division of the enemy's cavalry, which had halted to the south of the line Haplincourt-Villers-au-Flos (5 km. s. e. of Bapaume), was in contact with the 5th Calvary Division;

* This is a small stream which falls into the Somme at Peronne.

† Marle is in the Department of the Aisne, about 20 km. to the n e. of Laon: Roisel is a town on the Cologne already mentioned.

‡ St. Quentin on the Somme is about 10 km. to the west of Ribemont on the Oise, the point already mentioned where the enemy was reported to be.

¶ The valley of the Suippe begins about 18 km. to the n. e. of Châlons-sur-Marne. The river falls into the Aisne about 12 km. to the n. of Reims.

§ These 23 battalions were equivalent to 24, since the two chasseur battalions each consisted of 6 companies.

A second division of hostile cavalry was reported on the stream called the Cologne.

II. It was announced that the Army of the North would continue its forward movement on the 9th of September, its cavalry exploring ahead, and that the advance would be led by one division of infantry acting as general advanced guard.

III. The cavalry brigades of the 1st and 2nd Corps were united as a provisional cavalry division, under the orders of General Cabré, and a horse artillery group taken from the corps artillery of the 1st Corps was attached to this provisional cavalry division.

The 5th Cavalry Division and the Provisional Cavalry Division were united under the orders of General Duhesme, with the mission of operating against the hostile cavalry. This general had orders to attack the enemy's cavalry with his whole force, and in case of success, to press forward until contact was made with the heads of the infantry columns of the enemy, in the general direction Rocquigny (7 km. s. e. of Bapaume) Nurlu (10 km. n. e. of Peronne), in order to determine their strength and their positions.

IV. The general advanced guard to be formed by a division of the 2nd Corps, and to be designated by the general commanding that Corps. Directions: To push before it all parties of the enemy and to reach Bapaume (20 km. s. of Arras) on September 9th.

Itinerary designated: Beaumetz les-Loges (10 km. s. w. of Arras), Ransart, Ayette, Ablainzeville, Achiet le Grand (6 km. n. w. of Bapaume).

The main body of this division to cross at 6 a. m., the railway leading from Arras to Doullens (33 km. s. w. of Arras).

Zone of cantonment: Béhagnies, Sapignies, Favreuil, Avesnes-les-Bapaume, Grévillers, Bihucourt, Béhagnies (5 km. n. of Bapaume.

Headquarters: Biefvillers-les-Bapaume (3 km. n. w. of Bapaume).

Line of surveillance of the outposts: To the east of Bapaume, extending from Beugnatre (3 km. n. e. of Bapaume) to Thilloy (3 km. s. w. of Bapaume).

No organizations to be cantonned in Bapaume.

V. The zones of march of the two army corps to be separated by the road: Beaumetz-les-Loges, Ransart, Ayette, Ablainzeville,—this road being reserved to the 2nd Corps.

The heads of columns of the main body of the advanced guards to cross the railway between Arras and Doullens (s. w. of Arras) at 8:30 a. m.

Headquarters of the Army to be at Ransart (10 km. s. w. of Arras) at 8:30 a. m., and to follow behind the division acting as advanced guard.

During the march, all reports and information gathered to be addressed to the General Commanding the Army, at Bapaume, commencing at 7 o'clock a. m.

Cantonments: 1st Corps; Blaireville (9 km. s. of Arras), Hendecourt-les-Ransart, Boiry-Ste. Rietrude, Moyenneville, Hamelincourt, Boyelles, Boiry-Becquerelle, Beaurains, Agny, Wailly, Blaireville.

Headquarters: Boisleux au-Mont.

2nd Corps; Ransart, Mouchy-au-Bois, Les Essarts-les-Bucquoy (6 km. s. of Ransart), Ablainzeville, Ayette, Douchy-les-Ayette, Adinfer, Ransart.

Headquarters: Bucquoy (11 km. n. w. of Bapaume).

Headquarters of the Army: Courcelles-le-Comte (16 km. s. of Arras.

The troops to limit themselves to occupying and watching by detachments the roads and tracks traversing the front or flanks of the zone of contonments.

VI. (Prescribes the details of the Subsistence Service).

VII. Army Reports to be sent to Courcelles-le-Comte at 3 p.m.*

SEPTEMBER 9TH.

The foreign officers arrived by special train at Frémicourt (3½ km. e. of Bapaume), between 7:30 and 8:00 a. m. About this time, General Duhesme and his staff had halted at a point a little to the southeast of the village of Frémicourt, and his two divisions of cavalry were massed in the vicinity, the Provisional Division on the right. A new element had been added to his force in the shape of Captain Gérard's cyclist company, about 90 strong, representing 150 carbines.

The Northern cavalry had covered itself with a line of outposts, and patrols from these outposts were slowly beating up the country in front. The weather was thick, and a drizzling rain was falling, which at times degenerated into a mist and at times became a downpour. Owing to the peculiarity of the weather it was difficult to make out objects at the usual ranges. Parties of spectators, on foot, in carriages and on horseback were quite numerous, and such a party, on horseback, in such weather, might at the distance of half a mile be readily taken for a hostile patrol. Glasses in such weather were of little or no use.

* End of order.

Perhaps about 2 km. to the south of where General Duhesme was found at 8:00 a. m., the enemy's patrols were made out.

The patrols on either side did not interfere with each other, but fell back promptly on their supports. The Provisional Division, preceded by the cyclists, was directed upon the village of Haplincourt (6 km. e. of Bapaume), and was somewhat in advance of the other (5th Cavalry Division), which seemed to be making for a point on the Haplincourt-Bertincourt road, near the latter place (10 km. e. of Bapaume).

The cyclist company found a Southern squadron in the village of Haplincourt, but drove out this force easily. Pressing on to Barastre (s. of Haplincourt), the cyclists seized this village and barricaded themselves there, the enemy's cavalry having been discovered in force in the direction of Rocquigny (s. of Barastre).

The cyclists held Barastre in spite of the repeated attacks of the Southern cavalry, a whole brigade being occupied about the time of the grand cavalry charge, in the effort to dislodge them. In the meantime, while the Provisional Cavalry Division was passing around the village of Haplincourt, to the eastward, the 5th Cavalry Division, on the left of the line, suddenly came under the fire of all 4 batteries of the Southern horse artillery, and a line of the enemy's cavalry made its appearance to the south of the Haplincourt-Bertincourt road.

The Northern horse artillery was slow getting into battery, and in the meantime the Southern cavalry was advancing rapidly evidently intending to charge. The Northern cavalry had the disadvantage of not being already in line, and the movement to form front into line was retarded by the very muddy and sticky condition of the ground. Still, the Northern line managed to charge, though not in the best of shape, but a surprise was in store for General Duhesme. At the moment of charging to the front, he was suddenly struck in flank by one or two brigades of Southern cavalry (1st Division), which appeared unexpectedly in line on his left flank.

The charging lines stopped at the prescribed distance from each other, awaiting the decision. The Maneuver Director was not far off and his decision was given very promptly. The Northern cavalry was declared to be out of action until evening, as it had come into line under artillery fire, had charged in considerable disorder, owing to various circumstances, and had been charged in flank, while a force nearly equal was opposed to it in front.

General Dusheme therefore retired with his whole force in the

direction of his cantonments, north of the Bapaume-Cambrai road.

The Southern cavalry, unmolested, pressed on towards Bapaume. On reaching the outskirts of this village it encountered the head of the general advanced guard (the 8th chasseurs), which was just emerging from the town. The Southern horse artillery very promptly opened fire on this battalion, which quickly deployed, being supported by two regiments of infantry of the advanced guard which were already entering the town.

The advance of the Southern cavalry was thus definitely checked. The 4th Infantry Division, which was acting as general advanced guard, and whose orders were to reach and occupy Bapaume, having thus fulfilled its object, the maneuvers were arrested for the day. It was then about 11:30 a. m.

Orders of General de France, evening of September 9th. These orders, dated Courcelles-le-Comte, prescribed the operations for the 10th instant, as follows:

I. The enemy's cavalry is reported on the line Flers (6 km. s. of Bapaume), Le Transloy, Barastre, Bertincourt (9 km. e. of Bapaume).

II. The Northern Army will continue its forward movement to-morrow, the 10th of September.

The division forming the general advanced guard, supported by the two divisions of cavalry, will direct itself upon Nurlu by Villers-au-Flos (4 km. s. e. of Bapaume) and Rocquigny, driving the enemy before it.

It will issue (head of the advanced guard) from Bapaume at 6:00 a. m.

The cavalry divisions will protect the flanks of the division forming the general advanced guard.

Provisional Cavalry Division: general direction, Warlencourt (4 km. s. w. of Bapaume), Le Transloy, Nurlu (10 km. n. e. of Peronne).

5th Cavalry Division: general direction, Frémicourt, Bus (9 km. s. e. of Bapaume), Nurlu.

The main body of the cavalry divisions will cross at 6:00 a. m., the National Highway, Albert-Bapaume-Cambrai (running s. w. and n. e.).

The Commander of the Army of the North will march with the general advanced guard.

III. The 1st Corps will march in two columns by the roads:

a. Boyelles, Ervillers (8 km. n. of Bapaume), Mory, Beugnatre, Frémicourt, Haplincourt, Bus, Lechelle; (one division).

b. Gomiecourt (7 km. n. w. of Bapaume), Sapignies, Bapaume, Villers-au-Flos, Rocquigny; (one division and the corps artillery).

All the divisional artillery to be with their respective advanced guards.

The 2nd Corps will march by the route:

Achiet-le-Grand, Bihicourt, Grévillers, Ligny-Thilloy (3 km. s. w. of Bapaume), Beaulencourt, Le Transloy, Sailly-Saillisel (11 km. n. of Peronne).

The corps artillery with the advanced guard, divisional artillery with the main body.

The main body of the advanced guards will cross at 6 a. m. the front of the cantonments.

The regimental trains of the 1st and 2nd Army Corps will not cross without further orders the line Achiet-le-Grand (6 km. n. w. of Bapaume), Mory* (6 km. n. of Bapaume).

SEPTEMBER 10TH.

The foreign officers arrived at Vélu (railvay junction, 9 km. e. of Bapaume), at 6:30 a. m.

The weather was beautiful, and the ground had dried sufficiently to facilitate greatly the movements of all arms. The forward movement of the Army of the North was being executed according to orders. The Provisional Cavalry Division, pursuing its route through Warlencourt, Guendecourt (5 km. s. of Bapaume) to Transloy, encountered a cavalry division of the Southern Army between Flers and Guendecourt about 7:00 a. m. There was the usual cavalry charge, and the Provisional Division, being considerably inferior, was decided to be neutralized for one hour. The cyclists, who were accompanying the Provisional Division, were also neutralized for this time. This check left the right flank of the general advanced guard of the Northern Army uncovered, however the Southern cavalry did not follow up their advantage in any way, but retired to a position between Lesboeufs and Le Transloy. A combat was on the program for the day, and the plan imputed to General Kessler was to delay the march of his adversaries by forcing them to a partial action, thereby giving more time for his assumed reinforcements to come up.

In pursuance of this plan, Barastre (7 km. s. e. of Bapaume) and its outskirts had been occupied by a brigade (23rd infantry brigade), the village itself being held by one regiment of infantry. The village and its outskirts had been put in a state of defense. Most of this defensive work was purely imaginary, and nowhere

* End of Order.

about the village were any actual trenches seen. Sailly (11 km. n. of Peronne), Bus, and Lechelle (10 km. s. e. of Bapaume), had been occupied by three battalions, one in each, and the remainder of the Army of the South was well in hand, behind the line thus indicated. A detachment occupied Villers-au-Flos (4 km. s. e. of Bapaume). The 4th Cavalry Division was on the right flank, between Barastre and Bertincourt.

About 8:00 a. m. the head of the Northern general advanced guard (8th chasseurs, assigned to the 4th Infantry Division), had reached the village of Villers-au-Flos, and had driven out the detachment of Southern cavalry, and had deployed on the plateau to the south of this village and opposite Barastre. Coming under the fire of the Southern Infantry Regiment occupying Barastre, this battalion immediately intrenched. The whole of the artillery of the 4th division was rapidly brought into battery on the plateau of Villers-au-Flos, and the 8th chasseurs, supported by the fire of all these guns, and by one infantry regiment of the 4th Division which had just been brought up, was launched against Barastre.

During this attack, some sections of infantry were sent to occupy the plateau called "Epine Isolé," southwest of Villers-au-Flos. The position of Barastre was too strongly occupied, however. and the Northern troops were obliged to retire. The Southern Army was in the mean time rapidly deploying, the 12th Division on the right, the Provisional Infantry Division on the left, the Marine Brigade occupying the extreme left of the line. The village of Rocquigny was occupied in force.

As the rest of the Northern forces were coming into line very slowly, a vigorous counter-attack was made by General Kessler on the Northern line, at a point west and south of Villers-au-Flos, evidently with the intention of turning this village and forcing the Northern troops to abandon it. Epine Isolé, being very weakly held, was carried, and a vigorous assault fell upon the left of the position of Villers au-Flos itself.

The Southern assault on Villers-au-Flos, though delivered in fine style, was not successful. It appears to have been delivered a little too late. General Brugère, commanding the 2nd Corps, who was on the ground with his 4th Infantry Division, had received considerable reinforcements, the engineers had greatly strengthened the position. and besides, the heads of column of the 3rd Division (2nd Corps), were beginning to debouch from Beaulencourt. The 4th Division, as a result of General Kessler's assault, lost a little ground, but still obstinately held on to

Villers-au-Flos. But as the 1st Corps too was commencing to come up, one division being directed upon Barastre, and the other by Frémicourt and Haplincourt upon Bus, thus threatening to turn General Kessler's right flank, it was evidently time for him to withdraw. Under the protection of his cavalry and artillery, he commenced his retreat in echelon, and about 11:00 a. m., his whole line was retiring.

The newspapers report that the cavalry on both sides were engaged against each other during the retreat of the Army of the South. The Provisional Cavalry Division, on General de France's right, is said to have received another check from the cavalry opposed to it. This occurred between Lesboeufs and Morval (w. of Sailly), about 11:30 a. m. On the other flank, a cavalry action (indecisive), between General de France's 5th Cavalry Division, and General Kessler's 1st Cavalry Division, is said to have taken place about a half an hour earlier. On both flanks, of course, the Southern cavalry ultimately retreated.

A little incident took place about 10:00 a. m. near the extreme left flank of the Southern Army. There was a battery in position here, apparently without support. A small force of Northern cavalry, about one squadron, stealing up from behind a grove of trees, suddenly charged this battery in flank. When this cavalry was within about 150 yards of the battery, it was suddenly welcomed with a very lively fusillade from a battalion of infantry concealed behind the crest of a hollow road to the left of the battery. The attacking cavalry promptly decamped. The apparent exposure of this battery was probably a trap, a trap which was sprung very successfully.

The operations for the day were terminated about 2:00 p. m. By this time the Southern Army was supposed to have been driven back beyond the Tortille (a small stream which falls into the Somme, a short distance west of Peronne).

Orders for the cantonments of the Northern Army, evening of September 10th. These orders stated:

I. That the Army of the North had driven the enemy beyond the stream called the Tortille, and had established itself on the ground thus gained.

The 5th Cavalry Division was ordered to cover the left flank of the Army, and the Provisional Cavalry Division to cover the right flank, and to watch the crossing of the Somme.

II. Zones of Cantonments:

Provisional Cavalry Division; Bouchavesnes (6 km. n. of Peronne), Cléry-sur-Somme,* Feuillère (w. of Peronne), Hem, Maurepas, Le Forest.

Headquarters: Cléry-sur-Somme (4 km. n. w. of Peronne).

5th Cavalry Division: Hermies, Havrincourt, Trescault, Metz-en-Couture.

Headquarters: Metz-en Couture (15 km. s. e. of Bapaume).

1st Corps: Lebucquière, Vélu (10 km. e. of Bapaume), Ruyaulcourt, Neuville, Bourjonval, Ytres, Lechelle, Ferme des Quatre-Vents, Barastre, Villers-au-Flos, Beaulencourt, Riencourt-les-Bapaume, Haplincourt, (Bertincourt excluded).

Headquarters: Ytres (6 km. s. of Vélu).

2nd Corps: Le Mesnil-en-Arronaise (8 km. s. e. of Bapaume), Rocquigny, Le Transloy, Lesboeufs, Combles (10 km. n. w. of Peronne), Rancourt, Ferme du Gounernement (9 km. n. of Peronne).

Headquarters: Sailly-Saillisel.

Headquarters of the Army: Bertincourt (9 km. e. of Bapaume).

III. Outposts:

2nd Corps: Line of the Tortille, from Moislans (7 km. w. of Peronne), (excluding this point, junction with the Provisional Cavalry Division), to Etricourt (6 km. e. of Sailly), (excluding this point, junction with the 1st Army Corps).

1st Corps: From Etricourt, by Hill 132, to Metz-en-Couture (15 km. s. e. of Bapaume), (excluding this point, the junction with the 5th Cavalry Division).

IV. 1st and 2nd Corps: No distribution by the regimental trains; the troops will consume on the 11th, one day's reserve rations.

Orders for the operations of the 11th September. These orders, issued by General de France from his headquarters at Bertincourt on the evening of September 10th, announced.

I. That the enemy was occupying the left bank of the Tortille, the heigths of Equancourt (14 km. s. e. of Bapaume), the Signal of Chevain (w. of Nurlu), the Signal du Bois. and the Ferme St. Pierre (3 km. s. of Nurlu).

That their cavalry divisions were in contact with the cavalry divisions of the Army of the North.

That the Army of the North would attack the enemy on the following day.

* On some maps this place is entered as Cléry-sur-Somme; on this Map it is entered as Cléry-Créquin.

II. The cavalry divisions were ordered to seek and attack the enemy as follows:

The 5th Cavalry Division, the right flank of the enemy, in the direction ; Heudicourt (14 km. n. e. of Peronne).
The Provisional Cavalry Division, their left flank, in the direction ; Templeux-la-Fosse (7 km. n. e. of Peronne); and secondly, to oppose any demonstration of the enemy's cavalry on the flanks of the Army.

The main body of each of the two cavalry divisions was ordered to commence its march at such an hour as to cross the front of the cantonments at 5:30 a. m.

The generals commanding the cavalry divisions were ordered to send all information collected to the Commander-in-Chief and to keep themselves constantly in communication with him by means of orderly officers.

III. Army Corps to be assembled at 6:30 a. m., under the protection of the outposts, in the following positions:

1st Corps; one division and the corps artillery to the west of the Ferme des Quatre-Vents (10 km. s. e. of Bapaume);

One division towards Rocquigny (8 km. s. e. of Bapaume);

2nd Corps: one division and the corps artillery to the northwest of Manancourt (6 km. e. of Sailly).

One division to the northwest of Moislans (6 km. n. of Peronne).

IV. The corps commanders to have reconnaissances made by detachments drawn from the outposts, accompanied by staff-officers, with the object of determining the dispositions of the enemy, and of gathering information with regard to the approaches to the enemy's positions.

These parties to start at 4:30 a. m., and to reconnoitre the following fronts:

Ferme St. Pierre (s. of Sailly), Nurlu (2nd Corps).

Nurlu, Fins (15 km. s. e. of Bapaume), (1st Corps).

Reports of reconnoissances to be sent to Army Headquarters.

V. Commander of the Army of the North will be at 6:30 a. m. at the Ferme des Quatre-Vents.

Each corps commander to send to Army Headquarters one staff officer to maintain communication with the Army Commander.

VI. (Subsistence and trains).

Orders of General de France, September 11th, for the pursuit of the enemy.

These orders, dated at the Ferme des Quatre-Vents, at 6:45 a. m., announced that:

I. The enemy had abandoned the positions he was occupying on the left bank of the Tortille, and that his cavalry was in contact with the cavalry of the Army of the North.

II. The cavalry divisions were ordered to seek to regain contact with the retreating infantry columns of the enemy as follows:

The 5th Cavalry Division in the general direction of Pontru (8 km. n. of St. Quentin).

The Provisional Cavalry Division in the general direction of Vermand (9 km. n. w. of St Quentin).

The cavalry was ordered to attack the enemy in order to retard his march and to reconnoitre his positions.

III. One division of each Army Corps to commence the pursuit immediately in the direction of St. Quentin:

The division of the 1st Corps by Villers-Faucon (12 km. n. e. of Peronne), Le Veriguier, Pontru;

The division of the 2nd Corps by Templeux-la-Fosse (7 km. n. e. of Peronne), Bernes, Vermand.

IV. The remainder of the army to cross the Tortille and take up a position on the heights of the left bank and await further orders as follows:

1st Corps to the south of Nurlu, near Hill No. 148;

2nd Corps to the west of the road from Nurlu to Aizecourt-le-Haut (n. e. of Peronne), and on both sides of the road Moislans-Templeux.

The 1st Corps to have at its disposal the Rocquigny road and the highway (chaussée) Brunehaut (this road runs southeast from Rocquigny), Etricourt, Nurlu (without passing through Manancourt), and also the ground to the north.

The 2nd Corps to have at its disposal all the ground to the south of this road.

V. (Directions and positions of the trains).

VI. The Commander-in-Chief will march at the head of the division of pursuit of the 1st Corps.*

SEPTEMBER 11TH.

The foreign officers arrived at the station of Epéhy (15 km. n. e. of Peronne), at 6:35 a. m.

The division of pursuit of the 1st Corps commenced to pass

* End of order.

through the village of Liéramont (w. of Epéhy), about 8:00 a. m. The weather was beautiful and the roads were in fine condition. Marching raised little or no dust. The infantry companies counted about 96 in ranks. Adding sergeants, musicians, infirmiers, band, sick, etc., a strength of about 500 men per battalion was obtained. Some of the battalions appeared to be over 600 strong. There was no straggling, but it was early in the day and the men were fresh.

The march was rapid. Route step was used, of course, but the pace was regular at 120 per minute. The distances between units appeared to be unnecessarily great, but perhaps this was intentional to give the same length to the columns as if the organizations were filled up to war strength. There were no distances lost in marching, and consequently no closing up at an increased gait.

Halts were made after 50 minutes marching. The duration of the ordinary halt was 10 minutes, and the march was resumed on the commencement of the hours of the clock. The signals for the halts were made by the whistle. A preliminary blast was sounded by the battalion commander, and the second blast, repeated on the whistle also by the captain of the leading company, was the signal for this company to halt.

The regulations prescribe that the rear companies then close to their proper distances (if distances have been lost), and that the head of each company halts at the signal of its captain. When a company halts, line is formed toward the right side of the road, arms are stacked, and knapsacks are taken off or eased without further commands. The men are then allowed to leave the ranks. (Instruction pratique provisoire du 24 décembre 1896, sur le Service de l'Infanterie en campagne, p. 52.)

As the head of the infantry column approached the village, one company was detached from the column to pass around the village and explore the outskirts.

Occasional artillery firing was heard during the day, where the opposing cavalries came into contact. No reports of any of these rear-guard combats are available. The Southern cavalry was constantly on the retreat, so that the cavalry on the other side had always the apparent advantage.

The pursuit was stopped about 1 p. m.

Orders for cantonment, Army of the North, evening of September 11th. These orders, issued by General de France from his headquarters at Roisel (railway junction 10 km. e. of Peronne), stated that:

I. The Southern Army had established itself in a strong position on the left bank of the Omigon between Attily (8 km. w. of St. Quentin) and Pontru.

His rear guards had been repulsed by the divisions of pursuit and had abandoned the left bank of the Cologne, and his cavalry had been beaten by the cavalry of the Army of the North.

II. The divisions of pursuit and the cavalry divisions were ordered to continue their forward movement, and to drive back all parties of the enemy into the zone included between the Cologne and the Omignon.

III. Stations for the Army of the North, evening of the 11th of September. (The main body of both the 1st and 2nd Corps ordered to move to the cantonments at once):

Provisional Division of Cavalry; Zone, Bouvincourt (8 km. s. e. of Peronne), Vraignes, Tertry, Monahy-Lagache, Athies (9 km. s. of Peronne), Mons-en-Chaussée. Headquarters: Vraignes.

5th Cavalry Division: Zone, Honnecourt (40 km. s. e. of Bapaume), Aubencheul-aux-Bois, Gouy, Mt. St. Martin, Bony, Ferme Gillemont, le Petit Priel Ferme (4 km. e. of Epéhy).

Headquarters: Le Catelet (25 km. n. of St. Quentin).

1st Corps:

Division of pursuit in cantonment-bivouac in the zone, Hervilly (11 km. s. w. of Le Catelet), Jeancourt, Ferme de Favaque, Templeux-le-Guerard, Hervilly.

The main body of the 1st Corps in cantonments in the zone, Hargicourt (between Le Catelet and Hervilly), Lempire, Epéhy, Guyencourt, Villers-Faucon, Hargicourt.

Headquarters: Villers-Faucon (5 km. n. of Hervilly).

2nd Corps:

Division of pursuit in cantonment-bivouac in the zone, Ferme Montigny, Bernes, Hancourt, Brusle, the railway as far as Roisel (excluding Roisel), the railway as far as the Montigny Ferme (2 km. s. of Hervilly).

The main body of the 2nd Corps in cantonments in the zone, Railway from Roisel to Buire (5 km. e. of Peronne), (Roisel excluded), Buire, Bussu, Aizecourt-le-Haut, Aizecourt-le-Bas, Longavesnes, Marquaix (3 km. n. w. of Hervilly).

Headquarters: Marquaix.

Headquarters of the Army: Roisel (near Hervilly).

IV. Advanced posts on the line: La Haute-Bruyére, le Grand Priel, le Verguier, Vendelles, Ferme Senaves, Fléchin.

Connection between the 1st and 2nd Corps; Vendelles (3½ km. s. e. of Hervilly), occupied by the 1st Corps.

V. (Trains).

VI. Army reports to be sent to Roisel at 5:00 o'clock p. m.*

Orders for operations on September 12th. These orders, issued from Army Headquarters at Roisel, on the evening of September 11th, stated that:

I. The enemy's forces were occupying the line of the Omignon, from Vermand (10 km. n. w. of St. Quentin), to Pontru (6 km. n. e. of Vermand); they had put the villages of the bed of the valley in a state of defense and constructed works on the heights of the left bank.

The cavalry of the Army of the North was in contact with the enemy's cavalry.

From accurate information received it was known that a corps sent to reinforce the Southern Army was on the march towards St. Quentin, and that it might be expected to debouch on the 12th of September to the south of this town in the direction, Roupy (on the road from St. Quentin (8 km. s. w. of St. Quentin), Etreillers (about 3 km. to the north of Roupy).

The Army of the North was ordered to attack on the 12th of September; it was to attempt to hold the enemy all along his front, and to maneuver to turn his line by the north, so as to drive him back upon St. Quentin, and to inflict a check upon him before the arrival of the corps sent to reinforce him.

II. Orders for the cavalry:

a. The Provisional Division was to put one regiment at the disposition of the General Commanding the 2nd Army Corps, to reconnoitre on his right flank.

b. The remainder of this division to move down to the Somme to render impracticable all the crossings of this river between St. Quentin and Grand Seraucourt (10 km. s. w. of St. Quentin), and to delay by all possible means the arrival of the enemy's reinforcements.

The Provisional Division was to cross the front of its cantonments at 6:30 a. m.

c. The 5th Cavalry Division, assembled at 6:30 a. m. to the northwest of the Farm of Grand Priel (5 km. e. of Hervilly), was to hold the crossings of the St. Quentin Canal in order to protect the left flank of the Army. Subsequently, orders would be sent it to participate in the action.

III. The 1st and 2nd Corps, covered by their outposts, to be assembled as follows:

1st Corps:

* End of order.

Leading division to the north of le Verguier (4 km. s. e. of Hervilly).

Rear division and corps artillery, at Villeret (about 4 km. to the northeast of le Verguier).

2nd Corps:

Leading division at Vendelles (4 km. s. of Hervilly).

Rear division and corps artillery, at Bernes (near Vendelles).

The leading divisions to be assembled at 6:30 a. m.; the rear divisions at 7:30.

The balloon park to take station at le Verguier at 5:00 a. m. where the balloon would be inflated.

IV. The 2nd Army Corps to have for its zone of action the front Vermand, Maissemy (this point included): its first objectives to be the villages of the bed of the valley, afterwards the heights of the left bank (Bois d'Holnon, Min. (Moulin) de Villecholles, Hill No. 123).

The 2nd Corps to hold one brigade, as a general reserve for the right wing, at the disposal of the Commander-id-Chief; this brigade to take station first at Bernes.

The 1st Army Corps to have as its first objectives the villages of Pontru and Pontruet; afterwards the heights of the left bank (the ruined signal, signal of the Ancien Min. d'en Haut), and to attempt to turn the enemy's right flank in the direction of the Ferme des Trois Sauvages (a short distance east of the village of Gricourt).

This corps to hold one brigade, as a general reserve, at the disposal of the Commander-in-Chief. At the commencement of the action, this brigade to take station at the Ferme de Favaques (5 km. e. of Hervilly).

The bed of the valley leading from le Verguier to Maissemy, and afterwards the bed of the valley separating Maissemy from Pontru, to be the line of division between the two army corps.

V. A telegraph base to be established at 6:30 a. m., with posts at Grand Priel, le Verguier, and Vendelles.

The Commander-in-Chief and the corps commanders to be in constant communication with this base, the Commander-in-Chief by le Verguier, the 1st Corps by Grand Priel, the 2nd Corps by Vendelles.

VI. The Commander-in Chief will repair, at the opening of the action, to le Verguier; he will be at that point at 6:30 a. m.

The action will not be commenced by the 1st and 2nd Corps until orders have been given therefor.

VII. Unless further orders are received, the regimental

trains will not cross the line of the railway leading from Peronne to Epéhy.*

VIII. (Subsistence).

SEPTEMBER 12TH.

The foreign officers arrived at Vermand-Marteville at 7:00 a. m.

The Omignon, behind which General Kessler had taken up his position, is a stream of some importance, flowing through a marshy valley. It is dignified by the name of a river and forms a considerable military obstacle. The low heights which rise from the valley of the river form two or three successive ridges, of which the crowning one was occupied by the main line of the Army of the South.

Higher up the valley, towards Pontru and Pontruet, and in the direction of the Canal of St. Quentin, there is no water in the bed of the valley, as the river issues suddenly from the ground, lower down, like a huge spring. These circumstances favored the turning movement projected by General de France, provided the Army of the South held on to its original positions long enough to enable the turning column to aceomplish its purpose.

The Southern forces were supposed to be entrenched along the crest held by them. Actual trenches, had in fact been dug. and more were in construction about 9:00 a. m. These consisted of sections of trench about 40 feet long, at rather regular intervals, and these bits of trench simulated a complete line of shelter for the infantry. The fresh earth of the trenches was concealed, generally with the top of the sugar beet, with which most of the fields weae planted. The work appeared to have been done with the long-handled shovels and tools carried on the battalion carts, as no other intrenching tools were seen in use.

At Attily, just south of Vermand, a strong redoubt had been constructed by the engineers, barring the road from Villévêque.

The guns along the crest were in actual gun-pits. The limbers were all sent to the rear, well behind the crest. The guns were supplied from the caissons, of which there were two to each battery on the line. The caisson teams had been mostly unharnessed and sent to the rear.

The command of the crest was not great, some 200 feet above the bed of the valley, but the artillery position was very good

* The 12th of September being the last day of the maneuvers, and the operations terminating on this day after the action, the regimental trains will receive from the Corps Commanders and from the Generals commanding cavalry divisions, the necessary orders to march at 11:00 a. m., in order to reach the cantonments on the 12th in the evening.

and the guns commanded pretty much all the ground on both sides of the valley to a distance of some 3500 meters.

The 12th Division, General Kessler's own troops, occupied the right of the line, the Provisional Brigade, formed of the 9th and 18th Chasseurs and the 145th Infantry, was on the left. Nearly all the cavalry and most of the Marine Brigade were in reserve.

The artillery duel commenced shortly after 8:00 a. m. On their right, the columns of the Northern Army advanced to the attack, protected by the fire of three successive lines of skirmishers, which fused into one as the bottom of the valley was reached. The southern outposts on the right bank ot the Omignon were soon driven in, and the villages of the valley, which were supposed to be in a state of defense, were carried in a much shorter time than probably would have been the case in actual service. The firing lines of the Northern Army did not come on by successive rushes, at least on their right, but advanced steadily, in quick time, with occasional halts when cover was reached.

The resistance of the Southern forces was somewhat tame, but the hour fixed for the termination of the maneuvers was about 1:00 p. m., and the Southern line was then to find itself just northwest of St. Quentin. Successive defensive positions in rear of the first one had evidently been studied, and the problem for the Southern commander was evidently to retire his flank as the turning movement developed, until his line had reached its final position.

The continued efforts of the 1st Corps to get around General Kessler's right only resulted in his still further refusing this flank, until at 12:40 p. m., which was very near the time fixed for the termination of the maneuvers, the Southern line extended beyond the Cambrai-Châlons highway, and was considerably south of the road between Holnon and Fayet (4 km. n. w. of St. Quentin). His left at this time had been obliged to let go of Holnon.

As the Northern troops still continued the turning movement, General Kessler brought up two regiments of Chasseurs à cheval and moved them and 6 batteries of artillery (probably his corps artillery) well towards his right, and echeloned them in rear of this flank, on the crest of the ridge to the east of the Cambrai-Châlons highway and a short distance north of St. Quentin.

This cavalry appeared suddenly on the crest of the ridge to the west of the highway already mentioned, and moved at a trot to their new position, crossing the highway, here elevated, and

ascending and descending the extremely steep embankments without slackening the gait or creating any disorder.

Whether or not these troops were General Kessler's last reserve is unknown. It seems probable that he still had an additional force of cavalry in hand. He was prepared, in consequence of his last dispositions, to still further prolong his line to the right, or to form a crochet to the rear resting on St. Quentin. It seems probable also, that it was in contemplation also to dismount the chasseurs to fight on foot.

A little after 1:00 p. m., the reserve brigade on General de France's right had been brought into line on the enemy's right flank, and the signal for the final assault was given. Before the actual clash, however, the signal for the termination of the maneuvers was sounded, and immediately afterwards, General de France made his criticism in the presence of the Minister of War.

SEPTEMBER 13TH.

Day of rest for the troops.

SEPTEMBER 14TH.

Grand review at Villévêque (3 km. s. of Vermand).

A study of the plan of the review gives a very good idea of the dispositions of the troops and of the lines by which the various organizations reached their positions. These lines had been carefully studied so as to give, as a whole, the minimum amount of marching to the men. It was an ideal site for a grand review. The ground was perfectly level for miles, and the communications were sufficient for the troops to reach the ground and retire without colliding. St. Quentin, an important railway center, received thousands of visitors from all parts of France. It was an easy drive from this city to the reviewing ground. The railway station of Attily, close to the review ground, allowed thousands of pedestrians to gain the tribunes.

The foreign officers reached St. Quentin by rail, arriving at 7:30 a. m. From the station they were taken in carriages to Etreillers, where their horses were in readiness.

On the arrival of the President of the Republic, who was accompanied by the King of Siam, a salute of 101 guns (the regulation number), was fired by one of the horse batteries of the 1st Cavalry Division. In front of the Presidential tribune, and distant from it about 50 yards, was drawn up a line of officers who were to receive the decoration of the Legion of Honor. A battalion of the 13th Corps, with colors, field music and band, was posted behind this line of officers, as a sort of guard or escort of honor.

The foreign officers were formed in line according to rank at right angles with that formed by the French officers. The President passed along the line of foreign officers first, and then commenced the presentation of the decorations to the French officers, saluting each with the "accolade."

Decorations were also presented to a number of the foreign officers, but without any particular ceremony, the insignia being handed to each one thus honored by a staff officer attached to the President's Military Household.

The foreign officers then took up their position, mounted, in line opposite the Presidential tribune, and a sufficient distance from it to allow the troops to march past in the prescribed formations.

The weather was somewhat foggy; but before the review actually commenced, about 11:30 a. m., the fog had lifted, and there was nothing to obstruct the view.

The troops marched past in the following order:

First the cavalry, then all the batteries of horse artillery in one line, next, the 1st, 2nd and the Provisional Corps, in the order mentioned. The balloon park closed the march, the balloon being inflated and towed along by the cable-wagon at an elevation of about 150 feet.

The Commander-in-Chief, General de France, on account of a serious accident, passed the President's tribune at a walk, and then took up his station a short distance in front of the line of foreign officers.

The cavalry and horse artillery marched past at a gallop. The cavalry was formed by brigades, the regiments "accolés" in column of squadrons at half distance, sabers drawn.

The alignments were excellent and the distances well maintained.

The Army Corps followed in the order indicated.

The infantry marched past with arms at a right shoulder. The step was well maintained and also the alignments and distances. Arms were not brought to a carry on passing the President's tribune.

The cyclist company marched past after the infantry, cycles slung, arms at a right shoulder.

The balloon section passed in review at a walk. While the balloon was in front of the President's tribune, it was quite steady, but the officers who started in the car had been obliged to descend on account of several violent gusts.

The cavalry, after passing in review, formed line opposite the President's tribune. After the rear of the column, represented by the balloon section, had passed the President, and advanced a sufficient distance, the four divisions of cavalry, charged or rather advanced at a gallop, sabers drawn, towards the tribunes. The line was suddenly halted on arriving at a distance of about 100 meters from the tribunes. Sabers were presented, the whole line setting up a tremendous shout.

This charge. seen from the position to which the foreign officers had removed, just to the left of the President, was really a magnificent sight.

The review was followed by a breakfast given by the President of the Republic, to which all the foreign officers were invited.

PROFESSIONAL NOTES.

ARTILLERY MATERIAL.

a. Guns and Carriages.

Vickers' Quick-Fire Field Gun.

On Thursday, July 21st, Messrs. Vickers invited a number of artillery officers and other visitors to witness the performance of their quick-fire field gun at Eynsford. The idea sprang from the recent discussion in the United Service Institution, there being a strong wish to see what could be effected with the latest improvements. The gun, shown in the accompanying cut, discharges a 6-kilo. projectile—being, in fact, a 12-pounder—so that it illustrates what can be done with a full-sized field gun, not the piece of diminished weight that is the natural proposal to avoid the difficulties of recoil. The carriage had placed along under its trail a strong spiral spring and cylinder, terminating beneath the trail eye in a spade with a blade about 8 inches long and 18 inches wide. The front end of the spiral spring connection was attached to the body of the carriage; the cylinder and spade end was held by two chains, one on each side, to a point half way along the trail. On firing, the carriage ran back, closing the spring, the trail running back over the top of the spade and cylinder end for about 3 feet, when the spring effected the recovery, bringing the carriage forward again. When forced back by recoil the chains become quite loose, and then attachment is not so rigid as to prevent the trail being moved some distance right and left from the true line of the spring and cylinder. The spade after a time had worked a hole in the ground about 1 foot long and 2 feet broad. The ground was good turf and favorable. Judging from the tracks made by the wheels, the right wheel moved smoothly, while for some reason the left wheel jumped to some extent.

We have mentioned the important matter of recoil first, because its control is the essence of the question. It may be seen that 3 feet is a sufficient recoil to make the condition very different from those of naval or garrison pieces on fixed mountings. It cannot, indeed, be said that the gun was brought back truly pointed as in the previous round, nor did the layer attempt to keep his eye to the sights. On the other hand, he performed the firing, the lanyard placing him at a sufficient distance to prevent being struck by the recoil. The piece was, however, laid with great rapidity and accuracy, as may be seen from the following figures:

1. Four rounds of case were fired; the visiting officers from Woolwich took the time, which was $13\frac{11}{20}$ seconds. The ammunition was all fixed in metal cartridge cases, and fired by percussion.

2. Eight rounds were fired with common shell and percussion fuzes. The time from the first to the last report—that is, the time taken in firing seven rounds—was 44.4 seconds. The target fired at was 22 feet by 12 feet, at 1000 yards range. On this five out of eight rounds were well planted; one shell was premature and one low.

3. Six rounds were next fired with shrapnel and time fuzes, the fuzes having been already set. These were got off in 27 seconds, with excellent effect

4. The gun at the visitors' request was now trained 45° off the true direction, and the target sight was run down, and the fuze set at zero, so that every

Fig. 3

operation had to be performed afresh. One round was got off well in 10½ seconds, making a hit.

5. Four rounds were next fired with shrapnel, starting with target sight set wrong and gun not laid on the target. In 24 seconds after the word to fire the last round was got off, and all four appeared to give admirable results, all delivering their bullets on the upper half of the target.

For this practice ballistite was used in preference to cordite. The shrapnel shell contains 300 bullets, making up a 15-pound projectile, and the muzzle velocity is about 1800 foot-seconds. When the fuzes were supplied set the gun was worked by two men, with a little assistance from a third. To set the shrapnel fuzes an additional man is required. The question is, then, How does the above fulfil the conditions necessary to success in a field quick-firing gun?

It may be seen that there is, as already said, no flinching from a full-sized gun and full weight of projectile. On the other hand, the recoil is not so controlled that the layer was able to keep his eye on the line of sight, and another plan was followed by which the piece was well and quickly laid; but it is to be noted that the conditions were all well known, were favorable, and the layer a man of exceptional skill and activity. It would have been possible for an awkward man to have been injured in attempting what this man did. Again, fixed ammunition with a metal case was used, by which loading and firing were rendered more quick and simple; but this involves the complication and trouble which it is our present effort to avoid. The success achieved was undoubtedly remarkable, however, and shows how much may be effected under favorable circumstances without securing all the special elements which we think desirable. The good effect of the shrapnel especially deserves notice. The weight of gun carriage and forty rounds was 30 cwt.

—*The Engineer*, July 29, 1898.

Torpedo Guns Afloat and Ashore.

Fifteen years have elapsed since the experiments were started with the so-called "dynamite gun." But it is only within a few weeks, during the war between the United States and Spain, that any demonstrations have been made with the gun in actual warfare. This demonstration has been limited in extent. It has not as yet included a trial in the direction from which the best results are sure to be obtained.

The absence of the United dynamite cruiser *Vesuvius* at Guantanamo, Cuba, when Admiral Cervera's fleet made its exit from Santiago, prevented a practical demonstration as to the effectiveness of that vessel and her pneumatic guns against ships.

The guns and shells have been so frequently described that no attempt will be made to do so in this paper. The so-called "guns" are, properly speaking, torpedo-throwing machines, and should be considered only from this point of view. Comparisons, if any are made, should be drawn with the automobile and dirigible torpedoes, and not with cannon and their armor-piercing projectiles.

Before discussing the questions of the fields of usefulness of the pneumatic torpedo and other torpedo-shell guns, some review of the conditions involved in firing high explosives is desirable. There seems to be a lack of knowledge and haziness as to what should be accomplished, in the minds of many who have been endeavoring to produce some forms of shell having a high-explosive bursting charge. An effort will be made, therefore, to present the matter as definitely as possible.

The object to be attained by torpedo shell charged with high explosives is—

1. Torpedo attack of the underwater hull of ship.
2. Structure destroying.
3. Man killing or disabling.

Experiments have demonstrated that considerable charges of dynamite or other high explosives may be exploded in contact with heavy armor without resulting in serious damage. This appears to be the case, especially when the charge is exploded in the ordinary way, by impact alone, or when the charge is in contact with the target, but not in any way tamped.

Experiments have also shown that where the initial point of explosion of the charge is at the point of impact with the target, the ensuing damage is considerable less than when the initial explosion takes place at the *rear* end of the charge, before explosion can occur at the point by impact. The high explosives are capable of a number of orders of explosion, of varying degrees of intensity of action. An initial explosion of fulminate of mercury, coupled with a larger charge of dry guncotton, or its equivalent, appears to be necessary to secure a high order of explosion.

The more insensitive the explosive to shock, and, therefore, the safer to handle, the more difficult it is to secure the maximum effect, on exploding it. This is especially true where there is a large mass of the explosive and it is in compacted form in the shell.

The possibility of securing only a partial or a low order of explosion is frequently overlooked. The mere fact of being able to throw a large mass of high explosive is of no avail, if the full potentiality of the charge is not secured by a suitable detonation of that charge. When it is suggested that a large charge of this or that insensitive high explosive has been safely thrown, we find that the complete detonation of such a charge is assumed with insufficient basis of proof of the actual accomplishment.

If the shell contains large charges of the explosive, the walls of the shell must be necessarily thin, and perforation of the armor is out of the question; the explosion is likely to take place outside of the armor, doing but little real damage.

If it is desirous to have the shell perforate the armor and explode after perforation, the walls of the shell must be very thick, and the capacity of the shell for the explosive is very much reduced. Such a shell could not be of use to secure torpedo action against the under-water hull of the ship. Where large masses of explosives are thrown in a torpedo shell, they are not likely to produce any very notable effects, other than moral, on striking the armored over-water hull of a ship.

To produce effective torpedo action against the under-water hull of a ship, a considerable charge of high explosive must be thrown. To increase its danger radius and to provide for the greater subdivision of the under-water hull of the future, the charge must be made as large as possible. In making torpedo shells of large capacity, as has already been mentioned, the walls of the shells must necessarily be very thin.

In this last case unless the pressures in the gun are kept low throughout, there is danger resulting from the chances of the thin walls of the shell being crushed by the maximum pressure. In other words, the shell and its charge must be adapted to the desired objective of the attack, and cannot well serve both for successful attack of the under-water hull and armored over-water hull. Both kinds may have a field of usefulness, and they must be especially provided for one or the other purpose.

The shock of the "set-back" on firing a shell charged with high explosives is greatest on the lowest layer of the explosive. This becomes greater in proportion to the weight of the explosive. The ratio of weight of the charge to the total weight of the shell determines the proportion of the shock which must be safely sustained by the explosive. Where, then, the charge is very large, there is a twofold danger, resulting from a possible crushing of the necessarily thin walls of the shell and the greater ratio of shock sustained by the explosive.

It follows – 1st. That a small amount of high explosive can be fired safely from powder guns with ordinary charges of powder because of ample thickness of walls of shell and small ratio of total shock borne by the explosive.

2nd. Such shell may be made to perforate armor, carrying the explosive with it.

3rd. Where torpedo shell, having large charges and thin walls are fired, the maximum pressures must be low enough not to crush the walls of the shell, and ordinary guns and ordinary methods will not serve.

Consideration of the foregoing will indicate the reasons why the pneumatic gun system has thus far been the only one that has been successful in throwing very large charges of high explosives, and that without a single accident. All other methods, while successful as long as the charge of explosive was but a small percentage of the total weight of the shell, have ended disastrously when the proportion became greater than, say, 20%. They have, at times, met with some success, but such success was not sustained to any extent that would justify adoption into actual service.

The development of the gun was pressed to the construction of as large a caliber as 15 inches, because it was early evident that its greatest utility would be as a torpedo-throwing machine, designed chiefly for the attack of the under-water hull of vessels. To be successful there, the large charges were requisite. The over-water hull, where heavily armored, could not be perforated, and could not usually be much damaged by the action of a charge of high explosives. Considerable injury would ensue where such shell would strike the unarmored or more lightly armored parts. An ordinary projectile, however large in calibre, might perforate the over-water hull without necessarily putting the vessel out of action. But a perforation of the under-water hull by torpedo action is likely to prove fatal.

Torpedo guns, when used in land defenses, should be looked upon as auxiliary and supplementing the fixed submarine mines defending a harbor. The mines may be removed by various methods of countermining, and, once removed, are difficult to replace, particularly in the presence of an enemy. Not alone may the submarine mines be removed by the action of the enemy, but in the course of an action they may be removed by the defence in endeavoring to blow up the enemy's fleet maneuvering in the harbor. The fire of torpedo guns can, in such cases, be directed on that portion of the torpedo field where the mines may have thus been removed.

When the firing is from a fixed platform, as is the case in shore defences, it has been shown to be extremely accurate. This follows from the uniformity of the air pressures and great care in making the projectiles. Where the ranges can be ascertained, as is likely to be the case in seacoast fortifications, the great accuracy of firing which has been shown to be possessed by the pneumatic torpedo guns should make an attack, coming within their range of fire, extremely hazardous. As an example of the accuracy of fire obtainable from shore, the writer would mention that of some trials at Shoeburyness.

Three rounds were fired at about 2200 yards, of which two rounds entered the same hole in the sand, the other round being two or three yards from this. At 3500 yards five shots out of six were placed in a space no larger than a billiard table.

In an official test of three 15-inch guns in San Francisco harbor, 75% of the shots fell, at a range of 5000 yards, in a rectangle measuring 360 feet by 90 feet. The contract requirements were only 34% within such a rectangle. A rectangle of 210 feet by 153 feet would have contained all the rounds fired.

In the trial of the 15-inch gun before the United States Naval Board, of which Captain Casper Goodrich was president, the contract requirement of landing 50% of shell fired, in a rectangle 150 feet long by 50 feet wide, at a distance of 1 mile, was exceeded. The following extract from the report of the board is pertinent:

"The method of graphic analysis employed to ascertain the effect produced by the groups of shell fired at the three principal ranges shows that a moderate-sized ship, broadside on, whose center was anywhere between the limits of 1988 yards and 2218 yards, would have been struck by from one to five projectiles, either above or below the water-line. If end on, her center being from 1946 yards to 2248 yards removed from the gun, she would have received from one to seven of the nine shots fired. Again, were the ship an average ironclad, 333 feet long, with corresponding draught of water, etc., she would have received all of the nine shots, either above or below the water-line, when 2097 yards distant.

"There is, however, another effect which ought not to be neglected, viz., the torpedo action of a suitably fuzed shell passing under the ship. As the lateral errors are insignificant throughout the various series, it is fair to assume that the chances of inflicting damage on a vessel, either way placed, are thereby materially increased. Since the *Silliman* was destroyed in this manner such a supposition is logically admissible. Granting that it adds only one more chance to each phase, and we see that of the nine shots fired at 2100 yards, eight would have been effective against a 300-foot ship, end on, and distant from 2105 yards to 2126 yards.

"At the 1700-yards range a similar ship, broadside on, would have been struck by from one to three projectiles, according as her center passed over the space between 1625 yards and 1745 yards. On the other hand, if end on, she would have received an equal number when changing her distance between 1574 and 1786 yards; and the number of injuries received might be increased from one to two or from two to three, within the same limits, through torpedo action.

"At 300 yards range, a ship broadside on would have received from one to three shots between the limits of distance of 329 yards to 451 yards. End on, she would have received from two to three shots between the limits of 298 yards and 482 yards.

"It appears, finally, then, that projectiles, either carrying, or capable of carrying, 200 pounds of high explosive, were thrown to distances varying from 1¼ miles to 90 yards and that, at the ranges selected for grouping, viz., 2100 yards, 1700 yards, and 360 yards, not less than one-half of the projectiles fired fell in the same standard target with the trial shot."

The report of the board which tested the guns when on board the *Vesuvius* was equally good as to accuracy of fire obtainable.

The chief defect which was then noted was the failure of the fuzes to act. This, however, does not detract from the accuracy of fire obtainable, and has

since been remedied. The trouble in this last case was due to the use of a new form ot fuze without the necessary preliminary trial, which is always essential when modifications are made in any mechanism. While the general plan adopted may be correct, defects in minor details frequently cause failures. The well demonstrated accuracy bespeaks possibilities of securing effective results.

Recent experience in defending the harbors of the United States by means of fixed submarine mines has indicated the great inconvenience which the traffic of seaboard towns would find when measures are taken in placing the submarine torpedo defences for the harbor. Therefore, hereafter, in such cases, it might be well to place torpedo guns to cover such portions of the channel as are most needed for carrying on the traffic of the port, at a minimum of inconvenience. Of course, when an attack by a hostile fleet becomes imminent, these could be supplemented by placing more mines, which, however, would practically close the harbor for traffic. Meanwhile, before such action is taken, the torpedo guns in the shore defences will measurably protect against any sudden forays which the enemy might make.

With sufficient of these or similar torpedo guns mounted in the defences of any harbor, an enemy could not assail them with assured impunity. The shell of the torpedo guns would necessarily be as effective as the ordinary fixed mine is, having a similar charge, provided it is placed and exploded sufficiently near the enemy. That this may be done has been demonstrated by actual experiences, some of which have been cited.

In considering the torpedo gun on shipboard, criticisms have usually been made because of the difficulty of firing from an unstable platform, but other guns afloat are subject, in a great measure, to the same objection. The high-angle fire of the torpedo gun is often cited as an objectionable feature, but it has some advantages which are not ordinarily conceded. Among these are the following:

High-power guns, with their flat trajectories, have as their target only the vertical projections of the over-water hull of the ship. A very slight change of the angle of elevation of these guns produces very considerable change in the height at which the shot would strike the target. With the change of about one-fourth of a degree of elevation at one mile range, the shot would go under or over the point aimed at, at a vertical distance of about 23 feet.

The pneumatic gun, however, with its high angle fire, has as its target the vertical projection of the over-water hull of the ship, the entire deck and a zone around the ship, of from 10 to 40 feet, according to the charge. A change of elevation of one degree would make a change in the range of only about 60 yards. Thus with a slight variation due to changes in elevation, and the greater size of the available target presented, the chances of securing effective results are more than fair.

The high-angle fire from the guns as mounted in the *Vesuvius* also presents advantages for the attack of high sites in fortifications, as was practically demonstrated in the attacks at Santiago. This last use for the gun has never been advocated as likely to produce any great material results. These can only be looked for when the shell strikes within an inclosed space. In such case there is no question but that both the moral and material effects produced by the explosion are likely to be very great.

Considering the *Vesuvius* and her guns as compared to ordinary torpedo boats, it would seem that the combination is a much more effective one for

offensive action than that of the best class of torpedo-boat destroyers. This, unfortunately, has not been as fully demonstrated, practically, as could be wished, owing to the lack of opportunity. On the other hand, it has been shown that torpedo-boats have an infinitely smaller chance of coming near enough to the vessel they wish to attack so as to strike them with torpedoes. The *Vesuvius* could commence operations at 2000 yards with fair chances of success, instead of having to approach to within 300 yards, as is the case with the torpedo-boats.

It is most unfortunate that Admiral Cervera's fleet attempted to escape from Santiago at a time when the *Vesuvius* was probably coaling at Guantanamo. Had she been at hand she would have had some chance to get near enough to get in a shot or two. This is evidenced by the experience of the U. S. S. *Gloucester*, which, although no more protected than the *Vesuvius*, succeeded in getting within a mile of the enemy's ships without suffering any material injury.

The *Vesuvius* is not presented as an example of the best arrangement which could be secured by the pneumatic guns or any other torpedo guns in a vessel built for the purpose. She was the first of her kind and was the first swift vessel which was built in the United States. Everything was made to conform to the requirements of speed and to enable the ship-builders to fulfil the contract as to this. Being the first of her kind, defects of design were to be expected. There was so much skepticism as to her usefulness that but little effort was made to secure the improvements which experience indicated to be desirable. Nevertheless, the vessel appears to have done such service as to secure for her and the guns a higher degree of favor than has been heretofore accorded them.

Torpedo guns, capable of throwing very large charges of high explosives could be placed in a fairly well armored turtle-back ship, having high speed. The guns could be arranged so that they could be protected completely and kept altogether under the water-line until the moment of firing. Some of these torpedo guns could be arranged so that they could be trained should this be considered desirable. A vessel of this character, having a speed of, say, 25 knots, would be most formidable.

Tubes of large caliber could be placed in the bows of battleships and cruisers, having muzzles projecting just above the water-line, the body of the gun being entirely protected and under the water-line. Such tubes would be equivalent to giving the ship a ram of 1000 yards or more in length, and the chances of getting in this blow would be much greater than the possibility of securing a direct blow with a ram. Such guns, too, could be of large caliber and throw shells containing 1000 pounds of explosive to a distance of at least 1000 yards. For such work a gun would not have to be very long, and could easily be provided for. In the course of the writer's experiments he has held that pneumatic power was the only one available which assured fullest safety in throwing large charges of high explosives. Thus far, experiences in the United States and elsewhere would seem to have warranted this assumption.

The writer now believes, however, that it will be possible in the near future to arrange powder charges in such a way as to secure moderate and uniform pressures. This will demand a special kind of powder and a special arrangement which will prevent the possibility of the pressures attaining a higher point than experiments have demonstrated to be well within the limits of safety.

Thus far, we have not discussed the use of small high-explosive shells for field operation, but their radius of effective action is necessarily small. To be thoroughly effective, moreover, such shells should be exploded in the midst of a body of troops, and to do this requires an accurate knowledge of the range.

Comparing this with the effect of shrapnel, fired by ordinary field artillery, we find that the shrapnel, on bursting, throws out a sheaf of missiles, each one capable of disabling a man for a distance of between 200 and 300 yards in front of the point of bursting, and scattering in a cone having an angle of about 15°. This would give a dispersion of about 50 yards at a distance of 200 yards. Considering that the open order is the usual formation which troops take under fire, the chances of the shrapnel securing results are much greater than those of the torpedo shell. It is not desirable to use a ton to kill a man where a few grains will serve. The torpedo shell, if exploded in the midst of a group of men, will, undoubtedly, tear them to pieces and mangle them; but it is not desirable in war to more than kill men, and it is better to wound them rather than to kill them.

There can be but little question that torpedo guns, throwing shell containing very large charges, will play an important part in the warfare of the future.

Their rôle will be both offensive and defensive. For naval operations, they will largely replace the unsubstantial and expensive myth of the short-ranged automobile torpedoes. The first nation to recognize this and act accordingly in its naval armament will surely reap an enormous advantage in so doing. Whilst the present war between the United States and Spain has not afforded a practical proof of the power of the torpedo gun, as against war vessels, it has at least demonstrated that the value and importance of the automobile torpedo has been overrated.

Thus far the pneumatic torpedo gun has alone successfully thrown large qnantities of high explosives. A mere statement that some great thing may be done is not a sufficient basis for assuming it as an accomplished fact and proceeding to act thereon. A logical deduction from what has been actually done, gives a reasonable basis for a conclusion as to what is likely to be practicable.

But the practical execution of the idea, when it is a matter of throwing large masses of high explosives, must be carefully carried on, step by step, cautiously and surely. There is no room for errors or "I thought so's."

The writer's arguments and conclusions are intended to refer to torpedo guns in general, whether compressed air, gases in any form, or gunpowder are used for propulsion.

—Captain E. L. ZALINSKI, U. S. A.,
in *Cassier's Magazine*, September, 1898.

b. Armor and Projectiles.

Trial of Carnegie Krupp Plates.

We give herewith photographs showing results of a trial of an experimental plate made on Krupp's process. The special points of interest are, first, that Krupp's process should be adopted in the very home of the Harvey process; secondly, the severity of the test; and thirdly, the comparative action of ordinary uncapped and of capped shots.

The trial took place on July 13th last at Indian Head by the United States naval authorities. The plate measured 9 feet by 5 feet 8 inches by 6 inches. It was backed by 12 feet of oak and two $\frac{5}{8}$-inch skin plates held up by ten

bolts. The plate face was hardened to a depth of from 1.5 inches to 2 inches. The attack was made with a 6-inch gun firing Carpenter steel projectiles, weighing 100 lb. each.

The positions of impact on the plate are shown in Fig. 1. The data of the four rounds fired are shown in the following table :

Number of round.	Striking velocity.	Striking energy.	Calculated perforation through iron by Tresidder's formula.	Relation of calculated perforation to thickness of plate.	RESULTS.
	Ft.-sec.	Ft.-tons.	Inches		
1	2021	2832	14.1	2.35	Projectile smashed with about 2.5 in. penetration.
2	2237	3470	16.3	2.72	Ditto, with 5 in. estimated penetration.
3	2350	3830	17.7	2.95	Perforated, but remained in backing and broke up.
4 (capped)	1984	2730	13.9	2.31	Perforated plate and backing and broke up.

The effects of the rounds may be fairly seen by the photographs—Figs. 1 and 2. The first round near the centre caused a dish in the face round the point of impact about 7/16-inch deep; the shot spread to a diameter of about 12 inches. A bulge 1.5 inches long was formed at the back, but no cracks were effected, nor was any injury done to bolts or structure. The projectile, which was hardened to 3 inches below the bourrelet, was not broken up small, one fragment containing a large portion of it.

The second shot struck near the right-hand bottom corner. The projectile, which was hardened to about 2.5 inches below the bourrelet, broke up, a great part remaining welded in the plate. A bulge 4.5 inches high was formed on the back of the plate. The front was dished about 1/3-inch round the point of impact. The face flaked off to the extent shown in Fig. 1. There was no injury done to the structure and bolts, and the plate was not cracked.

The third round was fired with a charge of 25 lb. of California S. P. perforated cylinder powder. It was the hardest blow delivered in the trial. The shot was hardened to 2¾ inches below the bourrelet. It struck near the left-hand bottom corner—see Fig. 1—and perforated the plate and broke up, carrying all its fragments into the backing where they remained, being stopped by the skin. The hole in the plate was oval, its greatest diameter being 8.5 inches. The effect was a punching one, the projectile driving the disc of plate in front of it. The flaking of the face is shown in Fig. 1. The plate was not cracked, nor were bolts or structure injured. The fourth round was fired with a Carpenter projectile capped, thus weighing 104 lb. The projectile was hardened to 4 inches below the bourrelet. It struck low down to the right of the centre line—see Fig. 1. It perforated the plate, backing and skin, and broke up, barely entering the sand butt in the rear. The hole was oblong to a less extent than in the previous round, the greatest diameter being 6.75 inches. There was no dish in front, and but little flaking. The plate was not cracked, and bolts and structure were not injured.

Fig. 1. Face of plate.
(Point of impact of fourth round at cross-mark).

Fig. 2. Back of plate.

Front of Brown, Krupp, 12-inch plate.

The plate was naturally held to have shown remarkable powers of resistance. Its appearance was good both in face and back.

We would now point out features in this trial which appeared to us to be of special interest compared with our own trials. First, the plate was tested up to complete perforation. Round three, in which the shot stopped in the backing, is probably nearly the exact measure of the plate's powers of resistance, seeing that the plate kept out the previous round with only 113 foot-seconds less velocity. We think it probable, however, that a shot with even considerable increase of velocity might affect no more practically, seeing that the shot broke up and perforated by punching, for it may readily be admitted that a great amount of energy would be necessary to drive fragments and disc through the skin.

That perforation should eventually be only achieved by punching is extremely interesting, showing the behaviour of the face in defeating the entrance of the sharp point. The dishing of the face round the point of impact in this and the previous rounds seems to show how much toughness was called into action. The factor of this plate is enormous, namely, 2.95. This was a little beyond the actual factor of the plate's power of resistance, but that of the previous round, namely, 2.72, is very great, larger than we have hitherto met with. Very probably, our own excellent Sheffield Krupp plates would give just as good a factor, but they have not ever, so far as we know, been tested, and we see the value of the test being pushed thus far in exhibiting the manner in which the plate yields. Then, the behaviour of the capped shot is of the highest interest. The cap apparently enabled the shot so far to retain its point as to perform its boring action through the plate, and by this means to get through plate and skin, although breaking up, thus defeating the plate with a velocity of only 1984 foot-seconds, and a figure of merit or factor of only 2.31. Something of this kind, we think, must have happened, although the action must have been imperfect. We could greatly wish that we had been informed if the plate had been broken radially from the centre or point of impact of the shot's point, or driven out in a disc. Fig. 2 shows the piece of plate broken away. The report speaks of what is termed a "spur" at the point of exit about 1.6 inch high. The trial must, we think, go to establish the excellence of Krupp plates, and, further, the value of the cap on the shot point.

We may conclude by observing that, while this Krupp plate exhibited the usual characteristic toughness, we are again reminded how mild a tax is imposed on thin plates in the way of fracture. The energy per ton of round No. 3 is only 500 foot-tons supposing the plate to weigh about 5.6 tons. Doubtless the setting up of the shot produced a wedge of considerable diameter, which the plate's own resisting power thus brought upon it, but which it bore admirably.

—*The Engineer*, September 2, 1898.

The officers of the Ordnance Bureau of the Navy Department on July 13 tested the first armor plate made in this country under the Krupp process, the secrets of which were recently acquired by the Carnegie Steel Company. The plate developed qualities little short of marvelous, and the results are most gratifying both to the Government and to the manufacturers. The plate specially manufactured for this test was 6 inches thick, and was manufactured under the direct supervision of two employees of the Carnegie Company, who visited the Krupp works at the time the process was acquired and

familiarized themselves with every detail. While certain features of the process cannot be revealed, it can be stated that this plate was not reforged, and further, that it is the general opinion among ordnance officials that the face hardening was accomplished by means of a series of gas jets so arranged as to temper the face without localization.

The plate was attacked by four Carpenter armor piercing shells of 6-inch caliber, the points of impact being 18 inches apart—*i.e.*, 18 inches between centers, or 12 inches from rim to rim. Not until the fourth shot was fired with a capped projectile was it possible to get through the plate and backing, and the shell even then fell within a few feet of the backing, showing that the extreme limit of the velocity had been required to pierce the plate. None of the shots developed even the finest radial hair cracks, and only a slight flaking of the surface of the plate around the holes appeared, while the shell that pierced the plate made an absolutely clean hole, though within a few inches of three previous impacts. The Ordnance Bureau pronounces the plate tested to be the best armor plate ever subjected to ballistic test, either in this country or Europe, according to the most reliable published data.

In view of the remarkable qualities shown by this plate (photographs of which we reproduce herewith) the Department will further test it by firing additional shots at higher velocities and under modified conditions. In the meantime a 12-inch plate will be submitted by the Carnegie Company and tested most rigidly for the purpose of ascertaining whether in a thicker plate the resistance increases in proportion to the thickness. Examination of the 6-inch plate showed that the tempering had penetrated more than 1 inch into the face of the plate, and it is regarded as important to know what can be done in this direction with a thicker plate.

Experts of the Ordnance Bureau have calculated that on the basis of the official test of the best plate thus far produced in the world, manufactured at the Creusot Works in France, which developed a resistance of 1.41 as compared with wrought iron of equal thickness, the Krupp process plate just tested at Indian Head developed a resistance of 1.71. This is especially gratifying for two reasons: 1, Because the plate was the first experiment of the Carnegie Company with the new process; and, 2, because the plate tested was not reforged, a process which, it is believed, would have added materially to the resistance developed. Ordnance officials will not be surprised ahould a reforged plate treated by the Krupp process show a resistance of 2.50 as compared with wrought iron. The manufacturers of this plate have been congratulated by the Department upon the fact that their experimental plate should have developed such remarkable reslstance, especially as it is known that when the Creusot Works acquired the Krupp process the ballistic tests made on the first half score of plates showed them to be failures. What American skill and ingenuity will be able to develop in this well tested European process can only be conjectured.

—*The Iron Age*, August 18, 1898.

Brown's 12-Inch Krupp Plate.

We give herewith an official photograph of a Krupp process plate made by John Brown and Co., Atlas Works, and tested by Government trial on July 21st last by three blows of 12-inch Holtzer armor piercing shot, each weighing 714 lbs., striking with velocities of 1852, 1856, and 1849 foot seconds, with the effect shown in the figure. The dimensions of the plate are 10 feet by 7 feet

by $11\frac{1}{8}$ inches, and its weight about 15 tons. The calculated perforations of wrought iron by Tresidder formula are 23.65 inches, 23.70 inches and 23.60 inches; the figure of merit, had the second blow just perforated, would be 2.03—that is, the plate would have been equal to 2.03 times its thickness in wrought iron. It was, of course, much better than this, though it is impossible to say by exactly how much. The test as to energy or shock was great, that of the heaviest blow being 1138 foot tons per ton of plate, the total energy of the blow being 17,060 foot-tons, which, divided by the weight of the plate in tons, gives this result. One similar Vickers Krupp process plate was tested in a like manner on August 19th, 1897, and one Cammell plate recently. The Vickers plate's official photograph we gave in our issue of November 19, 1897; that of the Cammell plate is not yet obtainable. We do not wish here, however, to make a comparision between the results obtained, but to call attention rather to what is much more important to the country than any small difference in relative powers exhibited by individual specimens of plates manufactured by each English firm, namely, the fact that our three great Sheffield armor plate factories have achieved success in the manufacture of Krupp process plates nearly 12 inches thick. The 6-inch armor has long been made; plates of 12-inch thickness are much more difficult to manufacture by this process, but once the difficulty is overcome, may be turned out, we imagine, with rapidly increasing certainty and uniformity of results.

What the results are may be seen in this trial. The perforation test is very severe for thick plates, and although rending has begun in one case at the back (round No. 1), it is not the well-developed star-shaped tear opposite the point of impact that indicates that the shot's point is sound, boring well, and will easily complete its work and appear through. How much more energy would be required to effect perforation and carry the projectile through it is not possible to say. For this reason we must greatly commend the United States authorities for pushing their firing trials on to complete perforation. More striking is the shattering test. Three blows of about 1130 foot-tons per ton of plate produced only the amount of cracking shown in the figure, which is more tearing from the point of impact than actual fracture, and the wedging strain of a shot whose calibre exceeds the thickness of the plate is very great.

Of course we may be met by the objection, which we fully admit, that the hard face of the plate defeated the blow before the projectile got far enough in for the plate to find out what its diameter ar total weight was. Doubtless it is only by this means that the plates bear the blows as they do, but it remains also true that the greater the size and bulk of the shot the more work is necessary to break it, and the larger the portion of head which enters with wedging power, which can probably best be measured by the diameter or calibre of the shot.

On August 17th last two 4-inch Brown steel armor plates, each 4 feet by 4 feet by 4 inches, were each tested by the attack of three 5-inch Palliser shot, weighing 50 lbs., striking with the velocities of 1406, 1750 and 1750 foot-seconds. The plates were both non-cemented or face treated. One was slightly harder than the other. This showed some slight superficial cracks after attack. the other showed none, but the indentations in the latter were appreciably deeper than in the former. We do not give our readers prints of these plates, because there is hardly anything visible except the point of impact with its radial white splashes, which are characteristic of the defeat of chilled projectiles by steel armor.

—*The Engineer*, October 21, 1898.

c. Powder and Explosives.

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d. Torpedoes.

Aerial Torpedoes.

The chief questions involved, not only in warfare, but in daily life everywhere, of both men and other animals, are those of offense and defense, attack and resistance, or counter to attack. The race between offense and defence has resulted in the development of cannon of comparatively small calibre, but with great thickness of wall and tremendous weight, in order to withstand the enormous pressures necessary to impart requisite velocities to long and heavy armor-piercing projectiles. Powder space within the armor-piercing shell has been sacrificed to weight and strength of metal, reliance being mainly placed upon the smashing effect of a huge bolt of steel. Opposed to this we find the modern battle-ship clothed in a wall of steel so ponderous as to reduce mobility to a minimum.

With the advent of a system of throwing high explosives, in sufficiently large masses to render armor absolutely useless, we shall find navies discarding their armor, and everything will be made subservient to speed and mobility. This will work a complete revolution in the construction of ordnance and ships-of-war. Heavy ordnance, instead of being made, as at present, of small calibre, with thick and heavy walls, will be made of much greater calibre, and with comparatively thin walls. The projectile which will then be employed will be a thin shell, simply thick enough to support the mass of contained explosive in its flight from the gun; and the explosive will be sufficient in quantity to work infinitely more destruction upon any target than such projectiles as are at the present day thrown from heavy guns.

One of the requisites of primary importance to a system of successfully throwing high explosives in large masses, lies in the propelling charge—a suitable gunpowder, one which shall give a sufficiently low initial pressure, and maintain that pressure behind the projectile in its flight throughout the entire length of the gun, and a powder which will, with absolute certainty, burn alike at all times under like conditions, in order that predetermined pressures and velocities may be depended upon.

The Maxim-Schupphaus multiperforated smokeless cannon powder has been made commercially during the last five years and tested extensively by the United States government, and has finally been adopted by the army. It is a modification of the Maxim-Schupphaus multiperforated cylinder that the writer proposes to employ as a torpedo powder for throwing high explosives from ordnance.

Smokeless powders are consumed entirely by surface combustion, and it is obvious, therefore, that if one powder presents, pound for pound, a smaller combustion area to the flame of ignition than another, its combustion will exert correspondingly less initial pressure. The Maxim-Schupphaus smokeless torpedo powder presents only one-sixth the area of combustion to the flame of ignition that is presented by cordite. It, therefore, cannot give more than one-sixth the initial pressure under like conditions. As variations in pressures and velocities are also in direct ratio with initial burning areas, the torpedo powder having only one-sixth the area and being consumed under one-third the pressure, can vary only about one-eighteenth as much as cordite under the same conditions.

It is popularly supposed that the chief consideration involved in throwing high explosives from ordnance is the danger of their premature explosion in the gun due to the shock of acceleration. But this is not the case. The most powerful of high explosives, namely, wet guncotton and picric acid, known also under the names of lyddite, emmensite and melinite, are already thrown from high-power guns at the highest velocities. Now, as it is the length of column of explosive in a shell which endangers it from the shock of set-back or acceleration, we may increase the size of the projectile in cross-section indefinitely to provide greater space for explosive without adding in the least to the danger from shock in the gun. As the column of explosive in the 24-inch aerial torpedo proposed by the writer, and carrying half a ton of pricic acid, is not any longer than the column of high explosive now safely thrown in 12-inch shells, and as the writer employs the same kind of explosive, and as, further, the aerial torpedo will not be subjected to a high initial shock of acceleration, the half-ton aerial torpedo will be even safer to throw than the 12-inch shells now generally used by all the great powers.

The present 12-inch gun weighs about 50 tons, and is adapted to stand an initial powder pressure of about 35,000 pounds to the square inch. But this rapidly falls off toward the muzzle, making the average pressure a little over 20,000 pounds. The 12-inch projectile weighs from 850 to 1000 pounds, and carries from 72 to 100 pounds of explosive. The shells have a velocity of from 1900 to 2300 feet per second, and a range from ten to thirteen miles, according to the length of the gun, the weight of the shell and the character of the propelling charge. Now, as the energy imparted to a shot depends upon the amount of pressure per square inch exerted upon its base through a given distance, it is obvious that 10,000 pounds to the square inch exerted upon an area of base four times as great and maintained through a distance 25 per cent. longer must impart a much greater muzzle energy than can be imparted with a pressure of 20,000 pounds per square inch exerted upon an area one quarter as great for three-quarters of the distance.

With the advantages of greater length of travel in the gun, greater area of base, and better maintained powder pressure, we are enabled to impart to the 24-inch aerial torpedo a very much greater muzzle energy than is imparted to the 12-inch shell thrown from present ordnance.

Now, as with the same muzzle energy a projectile of twice the weight will be thrown at about three-quarters the velocity and range, we are enabled, with the advantages just mentioned in favor of the aerial torpedo gun, to throw a projectile weighing three times as much as the 12-inch shell, at more than three quarters the velocity and range. Such a projectile will consist of a ton of steel and half a ton of high explosive. The one system is as safe as the other; the one projectile may be substituted for the other; the only question involved is whether a projectile, weighing 850 pounds and carrying only 75 pounds of explosive, is as destructive a missile as one weighing a ton and a half and carrying half a ton of explosive. Is the 25 per cent. greater velocity of the 12-inch shell advantage enough to counterbalance the tremendous additional weight of metal and explosive of the 24-inch aerial torpedo?

The system involves no radical departure from the present forms of ordnance. The aerial torpedo gun of 24-inch calibre will weigh the same as the present 12-inch gun, and will have substantially the same outside dimensions, except being a little larger toward the muzzle and a few feet longer.

The aerial torpedo or projectile which will be thrown involves nothing questionable or intricate in its construction, and no new or untried law. It is built on known lines, based on demonstrated physical laws.

The following, from the April number of the *Journal* of the Royal United Service Institution of Great Britain, and which originally appeared in the London *Engineer*, will give an idea of what is already being done in the way of throwing high explosives from ordnance in present forms of shells. The quotation relates to some experiments upon the old British battleship *Resistance*:—

"The between decks is a sight never to be forgotten. Framing, splinter screens, partitions, and bulkheads have been rent into fragments by the bursting of the high explosive shells, whilst grim splashes of a yellow substance that have marked the places where shells have burst outside the plating betoken the character of the explosive employed.

"It is now an acknowledged axiom that high explosives will be employed in shells. Whether naval officers object to carrying them on board ship or not, they will, in future, be the principal ingredient by which shells are filled for coast and siege purposes; and already the nature of high explosives, to be used as a 'service' bursting charge for high angle howitzers in coast and siege batteries, has been practically determined.

"After exhaustive trials, all inventions in this direction, except wet guncotton and lyddite (picric acid), have been discarded. A satisfactory high explosive has been defined as fulfilling the following conditions:—It should be safe in manufacture, store, and transport, and stable under service conditions. It should be of a convenient form for filling shell, and safe to manipulate in the process. It must be capable of standing the shock of discharge in high-velocity guns, and must, on striking, detonate with violence and certainty, and without the aid of any dangerous fulminate. The explosive should be capable of having its sensitiveness increased or diminished as occasion may require, and a shell, when filled with it, should not detonate when hit by another shell.

"Of those high explosives experimented with, the two coming nearest to the standard are wet guncotton, which has been adopted by at least one European power, and lyddite, which is used in our Service. Wet guncotton will not detonate in a shell struck by another shell, and in this respect is more satisfactory than lyddite; but guncotton, to produce its best effect, must be compressed into discs to fit the interior of the shell, and the shell must, therefore, be made in two parts and screwed together,—a source of weakness and possible danger. Dry cotton and a fulminate are, moreover, required to detonate it. Hence lyddite, to which none of these objections apply, will probably be adopted as the high explosive of our Service."

Naval authorities must soon give due consideration to the aerial torpedo. From half a ton to a ton of high explosives can certainly be thrown with absolute safety and great certainty at all fighting ranges at sea, and if such quantities of high explosive, striking and exploding on board a battleship by impact upon its superstructure, will destroy the vessel or throw it out of action, or if such quantities, when projected into the water and exploding as submarine mines adjacent to the hull of a battleship, will suffice to blow her up or sink her, then the first shot of the aerial torpedo gun proposed by the writer will render obsolete every battleship in the world.

Immense sums of money will no longer be expended in armored protection which will not protect, and in the construction of huge and ponderous fighting

machines whose very size render them a more easy prey to the torpedo gun than a small and light cruiser, simply big enough to provide a portable and stable gun platform. If a projectile can be thrown which shall be sufficiently destructive to demolish anything and everything it hits, then, obviously, thereafter centralization of men and expense must be abandoned and men and weapons must be dispersed in order to form as many and as small targets as possible. Navies must fight in skirmishing order, exactly as armies on land now do.

If the battleship, forming a target ten times as great, offers no greater protection against the aerial torpedo than the small, unprotected cruiser, and costs ten times as much, and carries ten times the number of men, it is certainly not more than one-tenth as efficient a fighting machine. Anything revolutionary in character, however meritorious, always has a hard fight for recognition, especially in overcoming the opposition backed by enormous vested interests. It would be easier with a few cruisers armed with aerial torpedoes to make a scrap heap of every battleship of the combined navies of the world to-day than it will be to even secure the system a place for once in the line of battle.

If there is even a fighting chance for the aerial torpedo to work the revolution in naval constructiou which the writer predicts, then this matter is a subject for serious consideration, especially by the United States government before making the enormous expenditures in battleships which Great Britian has made. Half a million dollars will build and arm a light torpedo cruiser which will carry one 24-inch torpedo gun and two torpedo mortars. This will demonstrate the efficiency of the system. If it fails, it costs but five hundred thousand dollars; if it succeeds, it will save five hundred millions. The battleship must go.

The great distance to which enormous quantities of high explosives may be thrown by torpedo guns and mortars and the hitting qualities of these weapons, when the enormous size of the target is taken into consideration within whose area a torpedo. striking, will destroy a warship, render these weapons of supreme importance for coast defense.

Aerial torpedo guns when once successfully tried, either on land or sea, will cause a revolution in coast fortifications as well as in war vessels. Aerial torpedoes penetrating deep into earthworks before exploding will be disastrous. It will then be the weapon, rather than means of protection, that will be the dominating power in both attack and defense. The cost by present methods, in ammunition and wear and tear of guns in bombarding coast fortifications or towns, is quite equal to the amount of damage done. This will all be changed by the introduction of aerial torpedoes.

—HUDSON MAXIM in *Cassier's Magazine*, July, 1898.

WARSHIPS AND TORPEDO BOATS.

Lessons from the Battle of Santiago.

Since we discussed the information received as to the facts of the destruction of the Spanish cruisers by the American fleet, fuller accounts have come to hand. We may especially mention the official diagrams of hits made on the Spanish vessels, given in the *Scientific American* of September 10th, and the accounts of two correspondents who were eye-witnesses of the fight, one from the deck of the *Brooklyn* and the other from that of the *New York*, published in *McClure's Magazine* for September. These we do not propose to

review in any sense, although we are making use of information obtained from them in forming the conclusions which we think are to be drawn from the character and occurrences of the fight.

First, a few words as to the actual conditions of action. The correspondent on board the *Brooklyn* was probably exactly in the best position to see and report the progress of the engagement. We may remind our readers that the Spanish ships steamed out the harbor towards the west in succession, passing the west end of a line of United States men-of-war blockading the harbor. The *Brooklyn*, lying at the west end, was thus best placed to pursue the Spanish ships, both because she had some start as to her position, and also because she had the highest speed of any ship in both fleets. Mr. Graham's account is spirited and graphic, though here and there rather too florid for professional readers. No naval officer, for example, could accept the statement that "the situation for the *Brooklyn* now seemed desperate," because the Spanish cruisers were running towards her. She had the overpowering strength of the United States fleet with her. She had, no doubt, to avoid exposing herself to being rammed, which she apparently very easily did by turning her head to starboard, so as to circle round with her stern towards them. She fired one broadside from her port guns, but she necessarily lost ground in going to meet the Spanish ships, who must have gained on her as she circled. Certainly the United States fleet got under weigh with admirable promptness; but we must pass on to our discussion of the effect of the fire as a whole, and the lessons to be drawn from it. The curious fact is to be noticed in passing that the Spanish ships, whose object was to escape, ahd who would certainly have benefited by smoke to conceal them, used smokeless powder; while the United States ships, who were endeavoring to pour in as accurate and rapid a fire as possible, were much hindered by the fact that they had not smokeless powder. No doubt the evil was modified by the speed at which the ships were running, and it appears that officers were sent aloft on board the *Brooklyn* to tell the gunners the effect of their shooting. Probably the smoke would scarcely reach this height before it was left behind. Yet the directions seem to have been of a very general character, and the statement that "every shot is telling," while encouraging, was only correct if it referred to every shot that hit, for the large number that we know missed could hardly tell even morally on an enemy that was running from the *Brooklyn*; most properly so running, for it is absolute nonsense to talk as if the Spanish cruisers could do otherwise. When truth forbids us from crediting them with anything else, we must allow that the Spanish made a gallant attempt to get their ships out, and gave their lives lavishly to effect it.

To get an idea of the circumstances of the firing, we cannot do better than follow the account of Mr. Graham, on board the *Brooklyn*. Apparently the enemy next appeared as a dark mass through the smoke, and, after coming round, the *Brooklyn* attacked first the *Maria Teresa* and then the *Vizcaya*—generally from about a mile and a-quarter to a mile and three-quarters range —till she turned in and ran ashore, and lastly the *Brooklyn* gave chase to the *Colon*, who had managed to show speed enough to have gained a lead of over three miles. The *Brooklyn* was only able to make 17 knots, because she had been unable to couple her forward engines, so that the *Colon*, who had the advantage of getting up her steam deliberately, ought to have escaped, had she been in fair order. To come, however, to the gunnery of the Spanish ships, the *Maria Teresa* and *Oquendo*, with no heavy guns, and only ordinary 5.5 inch guns, never had a chance of successfully running the gauntlet of the

heavy battleships *Texas*, *Iowa* and *Indiana*, which fired on them, though they had not the speed required to follow the cruisers far. The *Oregon*, indeed, was able to keep up well throughout. The *Vizcaya* for a time had mainly the *Brooklyn* to deal with her. Mr. Graham writes as if the *Vizcaya* ought to have been more than a match for the *Brooklyn*. She certainly had thicker armor, especially at her belt, but this could not prevent her other parts being destroyed by the greater fire of the latter. Had all the guns been complete, the *Brooklyn's* entire energy of fire per minute is about 192,032 foot-tons, against 179,203 of the *Vizcaya*. Probably the *Brooklyn* could bring to bear three of her four 8-inch, and half of her twelve quick-fire 5-inch guns, giving an energy of 111,012 foot-tons per minute, against 107,625 foot-tons delivered by the *Vizcaya's* two 11-inch guns, and half of her ten quick-fire 5.5 inch guns. We fear, however, that the *Vizcaya's* heavy guns were non-existing, so she had only 71,580 foot-tons energy of fire, and a matter of fact, seems to have been able to deliver very little effective fire at all, partly from bad gunnery, and partly, perhaps, owing to injuries received in passing the slow battleships. Under these conditions the *Brooklyn* would be able to man all her light unprotected quick-fire guns, which we have not taken into account because men could hardly live at them in close action. Consequently the *Vizcaya* would be subject to all the *Brooklyn* could do, and in about twelve minutes the *Oregon* joined in and destruction rapidly followed, so that in six minutes she ran ashore hopelessly on fire. She had received five 8-inch, seven 5-inch, four 4-inch, and thirteen 6-pounder shells in all. The story of the *Vizcaya* is more or less that of all the Spanish cruisers, except the *Colon*, whose 6-inch plate protection to her upper structure and general condition put her in a very different position, and ought to have secured her escape had her speed been kept up. Their vital parts were protected by their belts, but they were destroyed by fire and wholesale cutting to pieces of their secondary parts and crews. This was effected mainly by the quick-fire guns, but few heavy gun projectiles going home, the above mentioned 8-inch shells being the best performance. Apparently, the most important elements for success in a running fight, such as took place, are, first, speed; secondly, gun power; thirdly, power of resisting conflagration. The first requires little comment. It is a question of actual speed obtained in trial and keeping the engines and bottoms of the ships in order. It is well to note that the notorious *Huascar* was eventually caught up and disabled only by cleaning the bottom of the *Cochrane*, and securing the slight superiority in speed that enabled the *Blanco* and *Cochrane* to overhaul the *Huascar*. We might indeed alter the old proverb, "For want of a nail the shoe was lost, for want of a shoe the horse was lost, and so the rider and kingdom," to read, for want of a cleaning the three knots were lost, for want of three knots the cruisers were lost. On the other hand, in virtue of a clean bottom some years ago Captain Kane was just able to withstand the wind that drove other ships on shore, and get his vessel safe out of Samoa Harbour. On the importance of our first point, then, namely, good engines and clean bottoms, we must all be fully convinced.

The second point is efficient fire. This seems to be best delivered in the form of heavy quick fire; that is, the fire of quick-fire guns mounted behind medium armor. This we have long insisted on. Leaving the question of conflagration till the last, so far as gun fire was concerned, the Spanish gunners might have stood to their guns had they been in 6-inch casemates, for the American 5-inch quick-fire guns could not by any possibility have perforated them. As to the question of accurate shooting, whatever was the exact

proportion of rounds that took effect, it is clear that the American officers found that they had considerable opportunity of testing their powers of shooting and improving it, in spite of some casualties, as they went on. We read, for example, of George Ellis deliberately measuring and recording the range in an exposed position, and his head being instantly afterwards carried away by a shot. The measure of success attained may have fallen short of what we should hope from results of practice firing; but however this may be, it is quite clear that accurate shooting was very desirable, and that the relative positions of any two ships engaged depended greatly on it.

Lastly, as to the incendiary action of the shell, this is a newer and more important point. Constructed as the Spanish cruisers were, primary attack of vitals was very difficult, and was not attained at all, we think. Secondary attack by quick-fire common shells practically settled the matter. How far is this of general application? Had the Spanish ships been built like the Germans, without wood anywhere, they could not have been set on fire. Are not the Germans right, and ought we not follow the same line? We specially have no doubt to keep in view the habitable character of our ships; but does not this action show us that wood must at all costs be given up? It seems strange that wood should burn as it does. We might explode loose powder on the floor of a room without setting it on fire. The fact is that a bursting shell drives large lumps of burning explosive into the wood, and once there, water would probably fail to extinguish it, seeing that it has its own oxygen incorporated in it in a solid form, and would burn freely under water. It seems hardly possible for a ship containing much wood to escape fire, especially under a quick-fire attack, for a 6-inch or 5-inch shell would set a vessel on fire nearly as well as a larger projectile. Are we then to depend only on quick-fire? We think not altogether, for we can conceive the case of two ships blowing each other's secondary parts to pieces to a great extent, and yet remaining intact as to their vital or primary parts. Once this action is pushed far, it is clear that the vessel which perforates the other's thick armor best is likely to carry the day. Naturally, however, different classes of ships have their special functions. It is interesting to turn to existing types to see how they would have acquitted themselves at Santiago. The *Esmeralda* would, we think, have found the very work she is suited for. Her high speed would have carried her rapidly away, and her tremendous fire would have made her very ugly to approach. On the other hand, we have repeatedly condemned the light pieces carried by the *New York*. It is curious that she should just have missed the opportunity of showing her powers.

—*The Engineer*, October 28, 1898.

Guns.

As far as the fighting in this war has gone, it has been almost wholly a question of gun fire, and chiefly between ships and batteries. It has long been a commonly received axiom that in modern wars, as indeed it was in former wars, the encounters between ships and batteries would be few and far between. The Americans themselves laid this down almost in terms on a review of the conditions and results of the British bombardment of the ports and batteries at Alexandria. At the first blush it would seem that this axiom had been upset for good by the experiences of the first few weeks of the war, for we heard of nothing but bombardments by the American ships, and there seemed, according to the accounts, to be no places left in Cuba that had not been bombarded.

I think we should pause before coming to a conclusion on this head. What was in the minds of the naval officers who wrote on the case of Alexandria was serious bombardment with the design of immediate conquest, or as a preliminary to a different form of attack which should result in conquest. There, again, the axiom was based on the well-ascertained fact that the fire from a given gun, mounted on land, was very much more accurate than the fire of the same gun, equally well served, afloat.

I had myself added to this the reflection that the cost of mounting a given gun afloat was so enormously greater than the cost of mounting the same gun on land that even if their accuracy was equal, it would be a losing game to pit the one against the other. It will not be possible, I think, to disestablish these two propositions. Then, again, the bombardments implied in the axiom were serious bombardments, not even punitive like that of Alexandria, but such as were to be persevered in for a definite and destructive end.

Evidently the axiom does not relate to cases which are mere reconnaissances, mere drawing of the fire of batteries in order to ascertain their situation and strength, or even for the minor purposes of putting heart into the seamen gunners and ensuring them practice. If we were able to take the first accounts of the exchanges of fire between the American ships and the Spanish batteries that came by cable across the Atlantic, every bombardment was "terrific," serious, and continuous, and left everything in ruins behind it. But as successive installments of news came in, the operation distinctly dwindled until we knew that, at best, there had been but a distant exchange of projectiles of a somewhat desultory character, and without a more definite object than reconnaissance.

But even of this, I think there has been more than most of us expected, and I doubt if most of us are quite clear as to the advantages which the Americans have derived, or have supposed they derived, from the practice. The early claim of both sides has almost invariably been that their projectiles had done enormous damage to the other side. But repudiation of damage has always come from both sides a little later.

We have every reason to suppose that the damage done by the ships to the batteries would not be heavy, and if any ships had been seriously damaged their withdrawal for repair would have made denial useless. The more sober telegrams have usually allowed that no great damage had been done to the Spanish batteries, and it seems quite certain that the only American vessel seriously damaged by Spanish artillery was the torpedo-boat *Winslow* at Cardenas. There is no doubt that she was badly mauled, suffering some loss in killed and wounded, and requiring to be sent back to Key West for repairs.

The axiom presupposed guns of equal power, equally well served, ashore and afloat. If, on the first exchanges of fire, as at Havana, the Americans found that the guns mounted were of inferior power to their own, or were worse served, the projectiles falling short or passing wide, it seems almost natural that the ships should amuse themselves, and alarm and disturb the enemy by an occasional distant cannonade, which was remarkably one-sided. I think, in fact, that this explains the somewhat unexpected phenomenon.

"Battle-ships," says the able Lieutenant-Commander Wainwright, of the United States Navy, and his remark applies equally to cruisers, "are not designed to attack land defenses, but to meet other vessels on the sea; and while they may, at times, successfully bombard fortifications, they will do so only under exceptional circumstances, and will need land forces to succeed in extensive operations."

This is a statement that will be very generally accepted, and I do not think it is at all shaken by anything that has lately taken place.

But near Manila, at Cavité, we have the gun exhibited as a power which would lead us to suppose that the Americans have damaged the Cuban and Porto Rican fortifications more than the Spaniards admit. Here we had Admiral Dewey's squadron engaging a group of Spanish ships, nominally protected by the fire of batteries, at very long range, said to be 4000 yards, and practically annihilating them in a very short time.

We must admit that the nominal gun power of the American ships was greatly in excess of that on board the Spaniards, but the point is that such rapid destruction was done at such long range, and that such batteries as there were should have made such a very poor show. If the Americans could readily destroy ships at 4000 yards, they could nearly as readily destroy batteries at the same range; and they would do both with impunity if the ships or batteries were armed with weapons of less range than their own, or if the shooting was worse than their own.

Then we come to some very simple but firm conclusions on the illustrations that gun fire has afforded us during this war. It is not safe to stand still with guns of a certain energy when guns of higher energy, without material increase of weight, are in existence. If we reflect in this way, we shall see, perhaps, that the increased energy that the Vickers-Maxim guns offer is a much more important and far-reaching war element than we might be disposed to think it at the first glance.

For ships the change is still more pronounced, for if report speaks truly, a given supply of ammunition for these quick-firing guns of increased energy occupies only half the space and half the displacement that a like supply would require for the ordinary guns of less energy. The advantages, no doubt, have seemed plain enough to the Admiralty, or they would not have accepted the guns; but nothing that I know of could have marked the necessity of a speedy rearmament on these principles than the fight, or rather the destruction at Cavité.

The advocates of extensive and increasing fortification by the power whose business, if she is to live, must be attack and not defence, are very fond of declaring that ships grow obselete and fortifications do not. The actual substance, or even the form, of fortifications may not, but if I am at all right in the views I have here expressed, this would seem to be a dangerous fallacy. Fortifications, to be of any use, must be up to date, and at least their armament must keep abreast with every change that is introduced afloat.

We all admit that it is the man behind the gun who makes the gun. We do not know, we shall not know, until we learn the actual armament of the Spanish batteries, how much of the Spanish failure to damage the American ships must fall to the share of the man behind the gun. But at least we can be sure that equal armament in ships does not represent equal force, unless there is equal skill and courage in the guns' crews. And also, that if the guns' crews in batteries do not receive as great and as careful training as the guns' crews afloat, the experience of Cavité might be repeated, though the very latest patterns of guns were mounted on the platforms.

—Vice-Admiral P. H. Colomb, R. N.,
in *Cassier's Magazine*, August, 1898.

GENERAL MILITARY MATTERS.

The Care of Troops in the Tropics.

Allusion has heretofore been made in these columns to the adverse criticisms passed upon the War Department in reference to its care of our troops. Doubtless there are, or were, shortcomings, to be credited largely to hurried mobilization and the necessity for creating resources that before were non-existent; but such are sure, in great measure at least, to regulate themselves in consonance with the knowledge derived from experience. Experience, however, is often a costly means of acquiring knowledge; and now the invasion of Cuba is un fait accompli, coupled with the fact that its climatic conditions and surroundings are quite different from anything hitherto experienced by either our regulars or volunteers, some of the late lessons taught our Anglo-Saxon brethren across the water in their occupation of tropical regions may acquire new values and afford new opportunities for application.

Formerly, the west coast of Africa excepted, the West Indian stations of the British army were regarded as the most malignant and deadly within the limits of the empire. To-day all occupied by white troops are remarkable for their cleanly, healthy, and salubrious character. Much the same may be said of the stations in the Orient, those of Central India more particularly, which region has a certain similitude to Cuba as regards topography; both lie between the 20th parallel of latitude and the Tropic of Cancer, and both alike present successive areas of low and alluvial soil, table-land, and hill country.

It has been declared that most of the ills of the soldier are of his own making; but, however true this may be, it in no way excuses military executives for shortcomings, and, notoriously, these very shortcomings in many instances have slain more men than either miasm or bullets.

The routine assignment of the regiments in the British Service constitutes no small factor in acclimatization. Except in dire emergency, this is progressive: The regiments that embark at Southampton proceed to Gibraltar, Malta and Cyprus, and from thence after a time are distributed to the Far East. The return is a reversal of the outgoing, the regiments being, however differently distributed; and next they, or a portion thereof, are forwarded to Jamaica, Barbadoes, Trinidad, and St. Lucia; a few, perhaps, reach Halifax before returning to England. Black troops—the West India regiments—are exclusively employed as garrisons at Demerara, Honduras, and on the African West Coast, and not infrequently in Bermuda, and occasionally at St. Lucia.

During the latter part of the last century and the early years of the present one, the death rate among the white troops in the two Indies was appalling During a service of five years, certain regiments, 1,000 strong lost all their original members; and one regiment, 860 strong, stationed at Apostle's Point —sometimes termed "Angel's" Point—at the entrance to Port Royal, Jamaica, lost more than one-third its strength in less than twelve months. The average mortality in Central India from 1838 to 1856 was 79.20 per thousand, and in the West Indies nearly or quite as great, though accurate statistics are not obtainable. In 1860 the mortality in India had fallen to 31.27, and in 1888 was but 15.73; in the West Indies for 1878 it was 16.18, which fell to 3.44 in 1888. From the latter figures, it would appear the Antilles are more healthy to Europeans than India, and this is true; but it must also be remembered the stations in the former are few, and being no longer of strategetical importance,

are located in the most salubrious situations. The conditions in the East are widely different. Regiments are obliged to do tours of duty in low-lying miasmatic districts, as well as in the more salubrious tablelands and hills, such being due to "exigencies of the service;" further, in India the population is so dense as to induce unsanitary surroundings that, by reason of an universal fatalistic belief and religious prejudices, are difficult if not impossible of eradication.

Long continued high temperatures; alternations of great atmospheric dryness and moisture; rapidly moving, perhaps dry and hot, air—all are common conditions in the tropics; and when to these is added the development of malaria, it is evident those accustomed to a temperate climate cannot support such surroundings without material detriment to health, except most extraordinary measures for protection are taken. For these reasons, if no other, the sanitary and hygienic conditions governing the soldier require careful but firm enforcement.

The tablelands and hills, being less malarious, and affording a more pure supply of air, should in so far as possible be selected for camps; further, in these situations liver maladies are uncommon, and intestinal fluxes neither so frequent nor violent. British military authorities lay great stress on the foregoing, and camps and barracks are located, in as far as opportunities permit, in consonance therewith.

Formerly the barracks employed for troops in the tropics were exact prototypes of the quadrangular structures that obtained in England—crowded, ill ventilated, stuffy, and hot; notoriously, at one time, the convict barracks at Bermuda were far superior to the quarters provided for the troops. To-day, the tropical barracks are large, commodious, two-storied buildings, elevated on arches of masonry several feet above the ground, and the walls exposed to the sun shadowed by wide verandas; there is also a double roof, with several feet of intervening space and permitting free circulation of air. Only one-half company is allowed in any one building, and only 16 to 20 men may occupy the same room, and to each is secured not less than 90 feet of superficial space and 1,800 feet of cubic space; besides thorough cross ventilation is provided for. Again, in tropical barracks no room is less than 24 feet wide and 20 feet between floors and ceilings. In some portions of India the barracks fairly deserve the titles of "palaces"—notably those at Allahabad—bestowed upon them by the natives, and they also afford ample evidence of the desire of the authorities to properly care for and conserve the health of "the nation's defenders."

When ordered for tropical service the English soldier is given an entire new outfit of clothing. Drill trousers and cotton jackets are the rule, perhaps also an extra tunic of scarlet serge. In India complete suits of khaki (a native grey or dust-colored cloth) are commonly worn, the regulation uniform being donned only when the conditions of climate and temperature demand. Many of the officers wear tunics of grass-cloth. The use of the kammerband, or wide flannel bandage, over the abdomen (preferably next to the skin) is general, and in fact often enforced, as constituting a wise precaution against the intestinal fluxes that are so prevalent and against a chilling that predisposes to malarial attacks. For central African service a brown drill uniform, similar to that adopted by the United States for the campaign in Cuba, is served out—a uniform that originated with the Cape Mounted Rifles; but the felt hat and leggins were speedily abandoned as unsuitable and cumbersome, and

replaced by ankle boots and a bamboo wicker or a "Tuson" helmet. The bamboo helmet, which is light, comfortable, durable, and every way effective, is covered with cloth and provided with a puggery; the "Tuson" consists of two bodies, one within the other, forming a complete air chamber, not only in the crown, but in the brim as well. Manifestly, the head covering of the soldier in the tropics should present the least possible surface to the wind, should not embody a single half-ounce of superfluous weight (hence should not be permeable to water), offer the greatest facilities for coolness, and yet not be cumbersome—conditions that cannot be filled by a structure of felt. Leggins, if of leather, and not of good quality, lose their suppleness and press on the ankle and instep; so also do those of cloth, in less degree, when they have been wet a few times and become saturated with dust—they only possess the advantage that at the end of a march they can be at once removed and cleaned, a bit of care that cannot often be inculcated or enforced.

Ankle boots with good serviceable tongues, and made to either lace or buckle, are now exclusively used by the British army, and have even been adopted by officers; they can be made to fasten the bottoms of trousers—purposely made short—to the ankles in a way to exclude dust. English regulation boots are made on the principles laid down by Camper, Meyer and others, and they are had in thirty-two sizes—eight in length and four in breadth—with very low, broad heels. The inner line is straight, so as not to push outward the great toe in any degree, and there is a bulging over the root of the same toe to allow for easy play of the joint; across the tread and toes it is very broad, so that lateral expansion may not be impeded. Great care is taken in the inspection of boots, which are of the very best quality and made in a specified way. The size is proved by standard measure, the excellence of the leather and quality of the sewing by selecting at random a certain number of each lot and cutting them up, when the slightest defect in one entails rejection of all. It is required there be not less than eight stitches to the inch, and even the number of strands, their thickness, and the waxing are carefully set forth in the specifications. Practically the same inspection governs the acceptance of clothing, which is always of the very best quality and altered by the company or regimental tailors to accurately fit the individual, as much cáre being taken in this regard as if preparing a suit for a Regent street dandy. It is the attention to even the more minute details of uniform that has given Tommy Atkins his reputation for smartness and neatness.

The daily ration of the British soldier in the tropics consists primarily of 24 ounces of fresh meat, 16 ounces each of bread and potatoes, 4 ounces of rice, 2.5 sugar, 0.71 tea, and 0 66 salt, besides pepper, vinegar, beer, etc. If salt meat is served, the amount is one-third less, but salt meats are abjured as much as possible, since scurvy is more prevalent in the tropics than elsewhere and, moreover, more fatal. Fresh vegetables are largely substituted for part of the potatoes and all the rice ration; lime juice is frequently served; and a convenient canteen at which all the articles are sold at absolutely cost price is always available, and even arranged for on a march. Experience has proved that the use of alcholic beverages is to be condemned in the hot climates and that even wines must be employed with moderation; but light wines, such as clarets, in reasonable quantity, diluted with water, are beneficial rather than otherwise; but as the private soldier cannot indulge in wine, he is provided with a light beer, but never in amounts exceeding one quart daily. The native liquors of both the East and West Indies are all vile, often drugged, and usually mixed with cayenne or other hot or pungent substances. The cheap

rum (caña—"nigger rum") of the Antilles, derived from sugar and cane waste, is especially pernicious.

—*Scientific American*, July 30, 1898.

BOOK REVIEWS.

Letters on Strategy by General Prince Kraft zu Hohenlohe-Ingelfingen. Forming the Second Volume of The Wolseley Series, Edited by Captain Walter H. James. London: Kegan Paul, Trench, Trübner & Co. 1898. In two Volumes, Pp. 417 and 345, respectively.

The author of these valuable letters on *strategy* has been long known to military students for his able letters on the *tactics* of the three arms. The present work, though well known and greatly appreciated by those who could read it in the original, is not so well known to English or American students who have not had that advantage, and yet it is far more interesting; probably because the brilliant and spirited generalities of strategy, involving as they do the movements of armies and the fates of nations, are always more entertaining study and reading than the dry details of tactics, the sphere of which is limited to the action of comparatively small bodies on the narrow field of battle.

General Prince Kraft is one of the foremost military writers of our day, and his work, aside from its value as a *military* essay and text-book, has very high literary merit, and is deserving of very careful study.

The Wolseley series has three of the best modern military works in its numbers, all from the German, viz: *With the Royal Headquarters*, General Verdy du Verrois, the present work, and *On the Conduct of War*, Lieutenant-General von der Goltz. Each has its own characteristic qualities, and all three are indispensable to the student of the art of war.

The editor has given the name of one of England's grand old soldiers to the series, and as the latter has proven his worth in the field in many a campaign it is interesting to note in his letter to the editor what views he entertains on the value of the *study* of military works:

"I hope the officers of her majesty's army may never degenerate into bookworms. There is happily at present no tendency in that direction, for I am glad to say that this generation is as fond of danger, adventure, and all manly out-of-door sports as its forefathers were. At the same time, all now recognize that the officer who has not studied war as an applied science, and who is ignorant of modern military history, is of little use beyond the rank of Captain. The principle of selection, pure and simple, is gradually being applied to the promotion of all officers, especially in the higher grades. As years go on this system will be more and more rigidly enforced."

After a brief introduction, in which the author discusses the relation of strategy to national policy, he takes up a few important campaigns, and after relating the events teaches the great principles of strategy inductively. The first campaign taken up is that of 1806, and it is ably presented, but an interesting feature in the comments is the explanation of the cause of the differences in this campaign and the more modern wars like that of 1870. For example, Napoleon had no large bodies of cavalry out to the front.

"One reason for this clinging of the cavalry to the slower infantry you will find in Napoleon's letters to his lieutenants, especially Soult. Throughout there is apprehension on account of the Prussian cavalry. Napoleon knew its excellence. He knew the weakness of his own, which, though numerous,

was inferior to the Prussian in efficiency. He instructed his infantry how to act against the latter. * * * Here then we have an instance where the tactical efficiency of the troops fettered strategy. He did not mean to make full use of his inferior cavalry until that of the Prussians had been broken by his infantry. It seems he wanted to show that Prussia was very weak and little worthy of notice. He would not allow the enemy the smallest success, not even in the first collision of the advanced troops. In this we recognize the general who knows the human heart. The first success in war, however small, is of incalculable value. If the troops are victorious in the first skirmish with the enemy, however small, the news of it raises the *morale* of the whole army; all long for similar glory. When, however the first collision with the enemy is unsuccessful, then, when the whole army becomes familiar with the idea that it may have to retire before the enemy, the feeling changes, the desire for fighting diminishes."

The next campaign taken up is that of 1859 in Italy, and his comments on this contain words of wisdom that we may well take to heart:

"Two things in the details of these arrangements have particularly attracted my attention:

"In the first place the orders are of formidable length and detail. They give to the several corps directions as to things, which it is the duty of the latter to arrange without specific orders. Conciseness of orders is of the utmost importance in strategy. For to insure that an order may be properly carried out, the first thing necessary is that it should be intelligently conceived and despatched in time. * * * How disastrous the consequences of too detailed a style may become, is shown by the battle of Austerlitz. I need not remind you that the writing of Weirotter's dispositions for the Austro-Russian army had not been completed when the battle began. It is only by the tendency for lengthy documents which prevailed for a long time with the Austrian staff, that I can explain why in almost all wars the Austrian troops appear so slow in movement. Having spent nearly two years with them, I know that this is not really the fault of the troops.

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"The other point in the arrangements for the advance which has attracted my attention, is the mode of subsisting the troops. Requisitions were only allowed to be levied by the brigade commissaries, under the direction of the corps commissaries, and issues were to be made by the latter in regular order. But in war, rations cannot always be issued in time, if the system of requisitions is centralized in the hands of the corps authorities, because the number of men drawing rations is too great and only a small fraction can receive their rations in time. The consequence is, that the troops either go hungry or help themselves and commit criminal excesses. As a rule both of these things happen.

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"An adequate food supply for man and beast is the ground-work of strategy. When visiting Marshal Radetzky's headquarters at Verona in 1855, that amiable old gentleman told me: 'If ever you hold a high command, remember, good soldier must have a full stomach! See therefore that your men have sufficient food. A hungry soldier has no courage.'

"There have been troops which have proved honorable exceptions to this rule and which have fought bravely although starving. Still Radetzky's words must be accepted as generally true. * * *

"When charged with the subsistence of the Reserve Artillery of the Guard Corps in 1866 I made my arrangements with a lively remembrance of old Radetzky's words.

"The very zealous commissariat officer proposed arrangements which would invariably have caused the troops to receive their rations two days too late. I took the matter in hand myself and so arranged it that none of the troops suffered from want of provisions, although after the battle of Königgrätz I marched through districts passed through by the retreating Austrian army with two Prussian corps marching ahead of me, and which were therefore pretty well drained."

What impresses one most in reading the account of this campaign is the fact that each side was for a long time entirely ignorant of the whereabouts and movements of the other. In this connection the author says:

"It may now appear incomprehensible that Gyulai should have rejected Kuhn's opinion, which later events have proved right. But I must tell you, that in war nothing is more difficult than to select the correct report from many conflicting ones. All men have not the luck and skill to see through the veil which hinders the vision. I had the opportunity once of admiring the composure and penetration of an army commander under whom I had the good fortune to serve. Upon receiving a very alarming report he said to the chief of staff: 'The man who brought this report was very much excited. Before we believe it, let us wait until some calm man confirms it.' And sure enough the man who had brought the report had been dreaming, as the saying is.

"Even the greatest and most experienced commanders have been thus deceived. Several historians state that the great king on one occasion only believed one spy (who was in the enemy's pay) and angrily rejected all reports conflicting with that man's statements, thus enabling the enemy to surprise him at Hochkirch. And did not Napoleon I, the master of modern war, believe for several days, in 1814, that he was drawing on the whole hostile army, when he was deceived by a screen of cavalry, which cost him his capital and his crown?

"But still every commander should cling with more or less stubbornness to an idea once formed, if he does not wish to have his arrangements disturbed by every conflicting report; in which case he would accomplish nothing."

The third campaign considered is that of 1870-71, and every phase of this is presented faithfully and clearly, illustrated with many personal experiences and thoughts, and brought home to us by means of many valuable lessons to be learned and stored for future use.

We have, in the first place, more comments on the great importance of brevity in orders:

"It was now decided at German headquarters, to execute the great change of front to the right, which had been in contemplation ever since the beginning of the war, in case the French army should execute its strategical deployment in rear of the Mosel fortresses. For the continued retreat of the French corps on the 7th and 8th August could not but indicate that they meant to do so.

"It is highly instructive to study the orders issued to this effect, their laconic brevity, omitting everything unnecessary, leaving full liberty of action to the army commanders. On the 8th August, a telegram of four lines sufficed to instruct the First Army, it now received one of three lines for the 9th, while the Third Army received an equally short telegram on the same

day. The instructions for the entire movement are comprised in twenty lines. They were issued from General Headquarters on the evening of the 9th.

"Gyulai's headquarters in the war of 1859 would have written as many pages for the same purpose."

The great harm worked by lengthy and detailed orders is still further commented on:

"In war it is of the utmost importance to be as sparing of words in instructions and orders, as of human lives in battle, or of detaching troops. For the longer the orders the more difficult they are to understand. In looking over those under discussion (Gyulai's) we find that their length was due mainly to two reasons. First, to their dealing with the arrangements for many days in advance and for so many different cases; secondly, because a mass of minor details were gone into which were partly matters of ordinary routine and partly the concern of the different corps and divisions. But such encroachments upon the sphere of subordinate commanders has much graver consequences than those due to their length. It destroys in the first place all initiative in the subordinate commanders. If the army headquarters staff accustoms the army to having every little detail regulated from above, then anything not specially ordered will certainly be neglected and good opportunities allowed to slip by."

The whole matter is thus summarized:

"Non-interference with the sphere of action of subordinates and calling them to account for sins of omission where opportunities might have been improved by spontaneous action, creates the spirit of the initiative. Interference by superiors with details really pertaining to subordinates, paralyses it."

Here are some brave words on the leadership in this great campaign that must warm the heart of the brave but unfortunate adversary, which at the same time illustrate the value of good leadership:

"With all due admiration for the incomparable bravery with which our infantry climbed up and held the Rother Berg at Spicheren, with which the infantry attacked again and again at Mars la Tours, with which the Guards at St. Privat crossed the bare slope of 2000 paces to the village, and for all the other deeds of our gallant infantry, I cannot refrain from doing justice to the stubborn tenacity of the French, their bravery in attack, their steadfastness under distress when invested in Metz. That French colonel whom I saw at the battle of St. Privat three times ride along the front of his skirmishers at a slow pace on his grey horse, with arms akimbo, and who finally fell into our hands wounded, was not surprassed in intrepidity by any of our excellent infantry field officers. Who would presume to consider himself superior to the unfortunate but brave infantry of the old Imperial Army of 1870 because it was compelled to lay down its arms at Metz and march past him as prisoners? Who will assert that we should not have fared the same way if the enemy had been led as we were and we as the enemy?"

The value and the dangers of fortresses in a theater of war are now fairly well understood, but it must be remembered that the following words were written a quarter of a century ago, when they were by no means so clearly comprehended by even the military world:

"Fortresses are valuable on the theatre of war if they cover the country in rear and front and on their sides to a certain distance. If they themselves need cover, they are an evil. In that case they are a terrible drag on the

freedom of action of the army. They compel the strategist to pay as much attention to them as to the enemy. They chain him to geographical points at the very beginning of the operations, after the strategical deployment, and even during the latter, at a time when rational strategy should pay no attention to geography, making the enemy's forces the sole object of its operations."

There are many other interesting remarks on the value, danger and effects of fortresses small and large, the difficulty of obtaining that so much to be desired brevity in orders, the great advantage of good scouting cavalry in front, of bridge material, and of a proper system of food supply, in addition to the great lessons in strategy to be learned from the three campaigns discussed.

Prince Kraft's work is an authority on modern strategy, and its study is essential for the soldier who aspires to high command.

The publishers have done their part with good taste, and clothed the work in an appropriate, substantial and effective dress. J. P. W.

Fünf Taktische Aufgaben über Führung und Verwendung der Feld-Artillerie. Gustav Smekal, K. u. K. Hauptmann des Generalstabs-corps. 2. Heft. Wien: L. W. Seidel and Sohn, 1898.

The second part of this excellent collection of studies or problems relating to the practical use of field artillery is quite as interesting as the first. It deals with the handling of the artillery of an infantry division, sent in pursuit of a defeated enemy. Six problems are given to be solved the solutions are added and finally these solutions are fully discussed from all rational points of view.

What we said of the first number applies with equal force to this one. The whole series constitutes a most valuable addition to the literature of field artillery *tactics*. In the discussion of the solutions all the important questions concerning field artillery are considered and developed: the proper subdivision of the artillery in the column of march, its early entry into action in large masses, the order of march of an infantry division (including the position of the divisional artillery), the part played by the artillery in reconnoissance and outpost duty, etc.

The applicatory method of instruction teaches the military student to apply the principles of tactics to particular situations, and hence constitutes a real school of *practice* in the field.

No better way of learning, applying, fixing in the memory and making second nature the principles of the use of artillery in a campaign is known. It is to the text books on tactics what the laboratory is to the lecture room.

Paper, print, diagrams and maps are all excellent. J. P. W.

Cuba and Porto Rico, With the other Islands of the West Indies: Their Topography, Climate, Flora, Products, Industries, Cities, People, Political Conditions, etc. By Robert T. Hill, of the United States Geological Survey. New York: The Century Co., 1898. Pp. xxviii. 429. With Index, Maps and Numerous Illustrations. Price, $3.00.

Not far from our borders is that wonderful and interesting West Indian region which ever since its introduction to European civilization has been an object of attraction and value for the Spanish, English, Dutch, French and Dane alike,—all anxious for participation and striving to share in its possession. Recent stirring events in that region have added another page to the

world's history. The West Indies now become of great importance and concern to us; especially Cuba and Porto Rico, whose political administration and commercial prosperity have been most disturbed of late years despite their superior natural resources.

"These islands were the commercial paradise of the first three centuries of American settlement, and lands now gone back to jungle sold as high as a thousand dollars an acre, 'in those booming days when sugar was at 32.' Here manufacturers found markets for all the weaves and notions of their making. The West India trade enriched the merchants of Barcelona and London, and the products of the plantations established many a fortune in England, France and Spain. Even now their trade exceeds that of all Mexico and Central America."

In the case of Cuba, whether it remains an independent republic or becomes a part of our territory, it is generally believed that the island will undergo an industrial and commercial renaissance which will afford openings for colonization and investment by the American people.

That the army will play an active and important part in this rehabilitation of these islands, fostering and encouraging their future development, is not to be doubted. For that reason, this volume should prove of great interest and value to officers of the service for information concerning the possibilities of the islands and the people with whom they will be brought in contact, and over whom they may have to exercise control. Aside from that, moreover, the thoroughness and completeness of the book, the interesting descriptions of places, people and institutions of these islands (the results of careful study and inspection of existing conditions), and the fairness of the opinions expressed, make it a valuable help for all who may desire to obtain a proper conception of the social and economic conditions of the West Indian Islands.

The volume before us forms a comprehensive book on the region as a whole and one which treats of the conditions as they appear to-day; giving the essential facts concerning the physical geography, climate, economic geology, agriculture, commerce and social conditions of these islands as well as the possibilities of their future development.

The author, Mr. Robert T. Hill, a professional geologist and geographer of high standing in the scientific world, has been engaged for years in explorations in tropical America. He first considers the West Indies and West Indian waters as a whole, the individuality and physical characters of the Great Antilles, then takes up the Island of Cuba to which about one-third of the book is devoted.

The physical geography of the island, its mountain and drainage systems are set forth in readable and entertaining style. As regards climate, "at Havana, in July and August the warmest months the average temperature is 82° F., fluctuating between a maximum of 88° F. and a minimum of 76°. In the cooler months of December and January, the thermometer averages 72°, the maximum being 78°, the minimum 50°.

"All in all, the climate of Cuba is much more salubrious than it has been painted. The winter months are delightful—in fact, ideal—while the summer months are more endurable than in most of our own country. The current impressions of insalubrity have arisen from an erroneous confusion of bad sanitation with the weather. While it is true that sickness follows the seasons, the former would be greatly allayed—almost abated—if public hygiene received proper official consideration."

A chapter of great interest is then devoted to health and sanitation—and here it might be well to quote the results of the author's experiences in the care of one's self in the tropics:

"The greater part of my life has been spent in traveling in unsanitary regions, including many years in the worst plague-spots of the tropics. By taking advantage of the best hygienic rules and precautions, I have been able to avoid the fatality which has overtaken many of my predecessors in geological exploration.

"Three rules I have followed invariably: first, to adapt my habits of dress, food, and hours of work and rest to those of the people of the country; secondly, never in any circumstances to drink a drop of native water where it could possibly be avoided, and if so, always to boil it. For this purpose I have always carried an alcohol lamp and a tin canteen, in which, when boiled water could not be otherwise obtained, I could myself attend to the matter. Twice when, in desperation after tedious exercises, I yielded to the temptation of drinking the native water unboiled, the results were almost fatal. The third rule has been never to linger around the densely crowded and unsanitary area of cities, and always to choose a room facing on the street.

"I have also carefully avoided the temptation to eat any kind of fruits which may be offered, especially bananas, which in the tropics, have an unpleasant acidity that deranges the digestion, not having undergone the mellowing and ripening process which this fruit passes through on its voyage to this country.

"Finally, it may be said that exposure to the heavy rainfall of the tropics, if not immediately followed by a change of clothing, invariably conduces to malaria."

The resources of the island, its harbors, railways, highways, its commerce and sources of wealth are dwelt upon and all forms interesting reading. "The chief opening for American energies will be found in the line of public improvements. Railways must be constructed, cities improved, waterworks and sewerage systems established, harbors dredged, and a thousand and one public works undertaken which Spain has long neglected and which are necessary to the large population which the island already possesses."

Of the Cuban people the author says: "Contrary to what has been represented, we have found them as a class neither ignorant nor lazy. * * * Although of Spanish blood, the Cubans, through adaptation to environment, have become a different class from the people of the mother country, just as the American stock has become differentiated from the English. Under the influence of their surroundings, they have developed into a gentle, industrious and normally peaceable race, not to be judged by the combativeness which they have developed under a tyranny such as has never been imposed upon any other people. The better class of *Camagueynos*, as the natives of the interior are fond of calling themselves, aside from the customary number of idlers and spoilt sons of wealthy parents one sees in Havana, are certainly the finest, the most valiant, and the most independent men of the island, while the women have the highest type of beauty. It is their boast that no Cuban woman has ever become a prostitute, and crime is certainly rare among them.

"While the local customs, habits and religion of these people are entirely different from ours, owing to race and environment, they have strong traits of civilized character, including honesty, family attachment, hospitality, politeness of address, and a respect for the golden rule. While numerically

inferior to the annual migration of Poles, Jews and Italians into the Eastern United States, against which no official voice is raised, they are too far superior to these people to justify the fears of those who have been prejudiced by the thought that they might by some means be absorbed into our future population.

"The men of the better classes are well bred and educated * * * owing to the influence of the climate and also the peculiarities of the government. which offers no paths of ambition to the aspiring youth, the men are generally listless, indifferent, and lacking in the energy peculiar to people farther notth."

The descriptions of the principal cities, enhanced by the numerous views and illustrations, give one a pleasing impression of their charm and picturesqueness. But we must refer our readers to the book itself contenting ourself with one closing paragraph:

"If good government be established in Cuba, it will undoubtedly become the Riviera of the western hemisphere. For natural beauty, picturesqueness, geniality of climate, and opportunities for rest, amusement and recreation, its diversified landscape, mineral springs, and surrounding seas are unequalled by those of Southern France and Italy. Here, undoubtedly, thousands of Americans will annually seek winter rest and recreation when peace is restored and sanitation is established."

The Island of Porto Rico, owing to current interest, is next considered and is described in the same thorough and at the same time entertaining manner.

Probably no part of the Antilles is more fertile than Porto Rico, and none so generally susceptible of cultivation and diversified farming. A single acre of cane yields more sugar there than in any other of the islands except Cuba. Possessing every variety of tropical landscape, fertile from the mountain tops to the sea, rich in pasture lands, shaded with beautiful groves of magnificent palms, moistened by thirteen hundred streams, with here and there a hot spring, its agricultural possibilities are immense.

The Porto Rican Spaniards of the upper class are the descendants of military men who, during the long period when the island was a mere garrison, formed alliances and settled within it. They are a good looking, happy, and prosperous set of people, and they have had the time and taken the trouble to acquire some education.

The peasantry are very primitive and ignorant but with the gradual diffusion of education, of which there is a lamentable deficiency, much of the grosser part of the character of the peasantry may be progressively removed.

The principal cities are concisely described, but evidently they do not present the same interest as those of Cuba and other islands considered.

The remainder of the book—a little over one-half—is devoted to Jamaica, the island of Santo Domingo, the Bahamas, the Lesser Antilles, and the other islands and groups of Islands of the West Indian waters or "American Mediterranean." The islands themselves are all interesting and the pictures the author draws make them appear very attractive. Although of less importance to us than Cuba and Porto Rico, perhaps, yet existing conditions in at least some of the former might easily show us what can be expected with the proper development of the latter. Where a stable and civilized government has been established, as in Jamaica, for example, which has permitted the development of the soil and climate, and has enforced sanitation, education

and public order, we are enabled to see how high a degree of culture may be attained in the West Indies.

After a brief consideration of the geological features of the West Indies, as regards the general paucity of mineral resources, and then the origin of the islands, the author devotes the concluding chapters of the book to the study of race problems in the West Indies and a short but pregnant inquiry as to their future.

"Concerning the future of these islands, of whatever nationality, there is but one hope and one end, and that is political or commercial annexation to the United States.

"As these pages are being written, ominous fears are expressed concerning the Cuban people; but Americans will see that the intervention of our government has been justifiable on every ground, and that that intervention in the behalf of the "Pearl of the Antilles" meant the beginning of a better and brighter day for all the West Indies. The establishment of trade relations in their natural channels, and the sweeping away of the antique and barbarous government of Cuba, will so influence the conditions of the other islands that they must inevitably be bettered."

The publishers have taken their usual care and pains in the production of the book. The paper is excellent and the print large and clear. The illustrations, of which there are over a hundred and fifty, are attractive and add greatly to one's interest in the text as well as to the appearance of the work.

A. H. Jr.

Manual for Cyclists, for the use of the Regular Army, Organized Militia, and Volunteer Troops of the United States, by Captain Howard A. Giddings, Connecticut National Guard. Hudson-Kimberly Publishing Co., Kansas City, Mo.

This little work of about 140 pages aims to furnish instructions for the practical use of the bicycle in the field. It deals with the drill of detachments engaged upon special service and as a combatant force, limiting the movements to the practically essential. It is clearly written, well arranged and neatly bound, and will prove of value to all who are engaged in the work of applying the bicycle for military purposes. J. P. W.

Annual Report of the Board of Regents of the Smithsonian Institution, to July, 1896. Washington. Government Printing Office. 1898.

The general appendix contains a miscellaneous selection of papers embracing a considerable range of scientific investigation and discussion, and showing the more remarkable and important developments in physical and biological discovery. Among them may be mentioned:

"Physical phenomena of the upper regions of the atmosphere," "Color photography," "Present status of the transmission and distribution of electrical energy," "Arctic explorations," "The war with the microbes," and "The utilization of Niagara."—a few of such as would possess an interest to all attracted by scientific progress.

BOOK NOTICES.

[These books will be fully *reviewed* as space becomes available.]

Photographic Mosaics: An Annual Record of Photographic Progress. Edited by Edward L. Wilson. Thirty-fifth year. New York: Edward L. Wilson. 1899. Pp. 286. With illustrations.

Explosive Materials. The phenomena and theories of explosion and the classification, constitution, and preparation of explosives. By Captain John P. Wisser, 7th Artillery. Instructor Department of Military Science, United States Artillery School. New York: D. Van Nostrand Company, 23 Murray and 27 Warren streets. 1898. Pp. 145. With index.

Mémoire sur les Vibrations Elastiques et la Résistance des Canons. Par M. E. Gossot, Lieutenant-Colonel de l'artillerie de la Marine, et M. R. Liouville, Ingénieur des poudres et salpêtres. Paris: Imprimerie Nationale. 1897. Pp. 93.

INDEX TO CURRENT ARTILLERY LITERATURE.

PERIODICALS CITED.

Abbreviations employed in index are added here in brackets.

All the periodicals are preserved in the Artillery School Library, Fort Monroe, Virginia.

ENGLAND.

Aldershot Military Society. *Occasional.*
Aldershot. Copies 6*d each.*

Arms and Explosives. [*Arms and Ex.*] *Monthly.*
Effingham House, Arundel Street, Strand, London, W. C. Per year 7 *s.*

Army and Navy Gazette. [*A. and N. Gaz.*] *Weekly.*
3 *York Street, Covent Garden, London. Per year* £1 12 *s* 6 *d.*

Canadian Military Gazette. [*Can. Gaz.*] *Fortnightly.*
Box 2179 *Montreal, Canada. Per year* $2.00.

The Engineer. [*Eng.*] *Weekly.*
33 *Norfolk Street, Strand, London. Per year* £2 6 *d.*

Engineering. [*Eng'ing.*] *Weekly.*
35-36 *Bedford Street, Strand, London, W. C. Per year* £2 6 *d.*

Journal of the Royal United Service Institution. [*Jour. R. U.S.I.*] *Monthly.*
17 *Great George Street, London, S. W. Per year* 24 *s.*

Journal of the United Service Institution of India. [*Jour. U. S. I. India*] *Quarterly.*
Simla, India. Per year $2.50.

Photographic Journal. [*Photo. Jour.*] *Monthly.*
12 *Hanover Square, London.*

Proceedings of the Institution of Civil Engineers. [*Proceedings I. C. E.*]
25 *Great George Street, Westminister, London.*

Proceedings of the Institution of Mechanical Engineers.
[*Proceedings I. M. E.*] 19 *Victoria Street, Westminister, London.*

Proceedings of the Royal Artillery Institution. [*Proceedings R. A. I.*] *Monthly.*
Woolwich, England.

Professional Papers of the Corps of Royal Engineers.
[*Prof. Papers Corps Royal Eng'rs.*]
Chatham, England.

Review of Reviews. [*Rev. of Rev. Austral.*] *Monthly.*
169 *Queen Street, Melbourne, Australia. Per year* 11 s. 6 d.

Transactions of the Canadian Institute. [*Trans. Canadian Inst.*]
58 *Richmond Street, Toronto, Canada.*

Transactions of the Canadian Society of Civil Engineers.
[*Trans. Canadian Soc. C. E.*]
Montreal, Canada.

Transactions of the East of Scotland Tactical Society.
[*Trans. E. of S. Tactical Soc.*]
51 *Hanover Street, Edinburgh, Scotland.*

Transactions of the Institute of Naval Architects.
[*Trans. Inst. Naval Architects.*]
5 *Adelphi Terrace, London, W.C.*

United Service Gazette. [*U. S. Gaz.*] *Weekly.*
4-6 *Catherine Street, Strand, London, W.C. Per year* £1 10 s 6 *d.*

United Service Magazine. [*United Serv. Mag.*] *Monthly.*
13 *Charing Cross, S. W. London. Per year* 27 *shillings.*

FRANCE.

Le Génie Civil. [*Génie C.*] *Weekly.*
6 *Rue de la Chaussée d'Antin, Paris. Per year* 45 *Fr.*

La Marine Française. [*Marine F.*] *Semi-monthly.*
23 *Rue Madame, Paris. Per year* 30 *Fr.*

Mémoires et Compte Rendu des Travaux de la Société des Ingénieurs Civils.
[*Ingénieurs Civils.*] *Monthly.*
10 *Cité Rougemont, Paris. Per year* 36 *Fr.*

Mémorial des Poudres et Salpêtres. [*M. Poudres et S.*] *Quarterly.*
Quai des Grands-Augustins, 55. *Paris. Per year* 12 *Fr.*

Le Monde Militaire. [*Monde.*] *Fortnightly.*
76 *Rue de Seine, Paris. Per year* 6 *Fr.*

Revue d'Artillerie. [*R. Artillerie.*] *Monthly.*
5 *Rue des Beaux-Arts, Paris. Per year* 22 *Fr.*

Revue de Cavalerie. [*R. Cav.*] *Monthly.*
Berger Levrault et Cie, Rue des Beaux-Arts 5, *Paris. Per year* 33 *Fr.*

Revue du Cercle Militaire. [*Cercle.*] *Weekly.*
37 *Rue de Bellechasse, Paris. Per year* 27 *Fr.*

Revue du Génie Militaire. [*Génie M.*] *Monthly.*
8 *Rue Saint-Dominique, Paris. Per year* 27 *Fr.*

Revue d'Infanterie. [*R. Inf.*] *Monthly.*
11 *Place Saint André-des-Arts, Paris. Per year* 25 *Fr.*

Revue Maritime. [*R. Maritime.*] *Monthly.*
L. Baudoin, Rue et Passage Dauphine 30, *Paris. Per year* 56 *Fr.*

Revue Militaire de l'Etranger. [*Etranger.*] *Monthly.*
L. Baudoin, Rue et Passage Dauphine 30, *Paris. Per year* 15 *Fr.*

Revue Militaire Universelle. [*R. Univ.*] *Monthly.*
11 *Place Saint André-des-Arts, Paris. Per year* 25 *Fr.*

Le Yacht—Journal de la Marine. [*Yacht.*] *Weekly.*
5) *Rue de Chateaudun, Paris. Per year* 30 *Fr.*

GERMANY.

Allgemeine Militaer-Zeitung. [*A. M.-Zeitung.*] *Semi-weekly.*
Darmstadt. Per year 24 *M.*

Archiv fuer die Artillerie-und Ingenieur Offiziere. [*Archiv.*] *Monthly.*
Koch Strasse, 68-78, *Berlin, S. W.* 12. *Per year* 12 *M.*

AUSTRIA.

SWITZERLAND AND BELGIUM.

SPAIN, PORTUGAL AND SOUTH AMERICA.

Boletin del Centro Naval. [*Boletin.*] *Monthly.*
438 *Alsina, Buenos Aires, Argentina Republica. Per year* $11.00.

Circulo Naval,—Revista de Marina. [*R. de Marina.*] *Monthly.*
Casilla num. 852, *Valparaiso, Chili.*

Memorial de Artilleria. [*M. de Art.*] *Monthly.*
Farmacia, num. 13, *Madrid, Spain. Per year, U. S.,* $3.40.

El Porvenir Militar. [*Porvenir.*] *Weekly.*
258 *Calle Montevideo, Buenos Aires, Argentina. Per year* 10 $ $\frac{m}{n}$.

La Prensa Militar. [*Prensa.*] *Weekly.*
Reconquista 1034, *Buenos Aires, Argentina.*

Revista Cientifico-Militar. [*Cientifico M.*] *Semi-monthly.*
5 *Calle de Cervantes, Barcelona, Spain. Per year* 32 *Fr.*

Revista da Commissao Technica Militar Consultiva. [*R. da Commissao.*]
Bi-monthly. Praça da Republica N. 32, *Rio de Janeiro, Brazil.*

Revista de Engenheria Militar. [*Engenheria Mil.*] *Monthly.*
27 *Rua Nova do Almada, Lisbon, Portugal. Per year* 1 $ 800 *réis.*

Revista do Exercito e da Armada. [*Exercito.*] *Monthly.*
Largo de S. Domingos No. 11, *Lisbon, Portugal. Per year U. S.* $6.00.

Revista General de Marina, [*R. G. de Marina.*] *Monthly.*
56 *Calle de Alcalá, Madrid, Spain. Price U. S.* $4.45.

Revista Maritima Brazileira. [*R.M. Brazil.*] *Bi-monthly.*
Rue do Conseheiro Saraiva n. 12, *Rio de Janeiro, Brasil. Per year* $5.00.

Revista Militar. [*R. Mil. Portugal.*] *Semi-monthly.*
262 *Rua da Princeza, Lisbon, Portugal. Per year,* $2.60.

Revista Militar. [*R. Mil. Chile.*] *Monthly.*
Santiago, Chili.

HOLLAND AND SCANDINAVIA.

Artillerie-Tidskrift. [*Art. Tids.*] *Bi-monthly.*
Stockholm, Sweden. Per year, U. S., $1.75.

De Militaert Gids. [*M. Gids.*] *Bi-monthly.*
De Erven F. Bohn, Haarlem, Holland. Per year, U. S., $2.00.

Militaert Tidsskrift. [*M. Tids.*] *Bi-monthly.*
Copenhagen, Denmark. Per year, U. S., $2.50.

Norsk Militeert Tidsskrift. [*N. M. Tids.*] *Monthly.*
Christiania, Norway. Per year, U. S., $2.50.

RUSSIA.

Artilleriiskii Journal. [*Art. Journal.*] *Monthly.*
Furschtatskaia Ulitza, St. Petersburg, Russia.

Razviedchik. [*Razv.*]
KoloKolwaia Ulitza, No. 14, *St. Petersburg, Russia.*

Russkii Invalide. [*Invalide.*]
Wadizdinskia Ulitza, No. 48, *St. Petersburg, Russia.*

ITALY.

Rivista di Artiglieria é Genio. [*R. Artig.*] *Monthly.*
Tipografia Voghera Enrico, Rome. Per year 30 *L.*

Rivista Marittima. [*R. Maritt.*] *Monthly.*
Rome. Per year 25 *L.*

UNITED STATES.

American Journal of Mathematics. [*Jour. Math.*]
John Hopkins University, Baltimore, Md.

American Machinist. [*Amer. Mach.*] *Weekly.*
256 *Broadway, New York City. Per year* $3.00.

American Manufacturer and Iron World. [*Man. and Iron World.*] *Weekly.*
59 *Ninth Street, Pittsburgh, Pa. Per year* $4.00.

Annual of the Office of Naval Intelligence. [*Naval Intelligence.*]
Washington, D. C.

Army and Navy Journal. [*A. and N. J.*] *Weekly.*
New York City. Per year $6.00.

Army and Navy Register. [*A. and N. R.*] *Weekly.*
Washington, D. C. Per year $3.00.

Bulletin of the American Mathematical Society. [*Bulletin Math. Soc.*]
University Heights, New York City.

Cassier's Magazine. [*Cas. Mag.*] *Monthly.*
3, *West* 29*th Street, New York City. Per year* $3.00.

Digest of Physical Tests. [*Digest.*] *Quarterly.*
1424 *N.* 9*th Street, Philadelphia. Per year* $1.00.

Electrical Engineer. [*Elec. Eng.*] *Weekly.*
203 *Broadway, New York City. Per year* $3.00.

Electrical Engineering. [*Elec. Eng'ing.*] *Semi-Monthly.*
443 *The Rookery, Chicago, Ill. Per year* $1.00.

Electrical Review. [*Elec. Rev. N. Y.*] *Weekly.*
41 *Park Row, New York City. Per Year* $3.00.

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APPLYING CORRECTIONS WHEN RANGING BY THE FORK SYSTEM.

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INTRODUCTORY.

In the *Journal* for March-April, 1898, there is a translation of a most interesting paper by General von Rohne. It is entitled "Concerning the Reliability of Range-Finding Shots." I draw attention to it here, however, not on account of its interest, but in common honesty, for I regret I cannot claim my system tallies exactly with his. Even so, mine may be sufficiently accurate for practical purposes; and that, it will be seen, is what I aim at. The General calculates the chances at any elevation at any stage of the ranging, but I hope to show how, without such calculations, proper corrections may be applied by simple addition, yet in such a manner that the range shall be determined with the least average expenditure of ammunition. The General truly says the subject is still in the air. It is well known how easy it is to go astray even in the elements of probability, and it is with the greatest diffidence, yet with the hope of criticism and with the expectation of inducing others to consider the subject, that I venture to put my system forward.

If it receives any approval and consent, I hope, on some future occasion, to show how, with a few rules, it may readily be applied in the field up to 20 rounds a minute. I am no mathematician, yet I venture to put my conclusions forward, for I have proved them in many thousands of cases during the last seven years, to give better results than those usually obtained—about 16% better.

With "exact" observation of fire, that is when the amounts short or over can be measured, the process of ranging is simple enough. We have the rule: When ΣR, the algebraical sum of the observed results since the last correction, exceeds P, the probable error, then correct $-\frac{\Sigma R}{n}$, where n equals the whole number of rounds observed. With "exact" observation, besides knowing the amounts short and over, we assume we can correct to any elevation. But in the fork system all is different: We can only observe + and —, and we are forced to correct 25, 50, 100, 200 or 400 yards, without using intermediary corrections. We can rarely, if ever, give the "exact" corrections, we must be satisfied if our forks are what von Rohne's translator terms "correct."

P, THE PROBABLE RANGING ERROR AND HOW TO FIND IT.

All systems of ranging depend on the probable ranging error P. I am in favor of allowing for misobservation in a manner differing from the General's. It is clear there are other matters besides misobservation to be taken into account: For instance, the target cannot be behind the gun, nor, practically, beyond the top range of the tangent sight. And there are other influences, which, however, may all, I venture to think, be allowed for as follows:

1. Work out the gun range as usual, that is, the elevation that should have been used. Also the error of each round.
2. Work out as usual p_s, the probable error of shooting.
3. Add up arithmetically all the differences between the gun range and the elevations actually ordered.
4. Work out all the elevations that would have been ordered had there been no misobservation, abnormals, slips, etc.
5. Add up arithmetically all the differences between these last elevations and the gun range.
6. Subtract (3) from (5), divide by the number of rounds and multiply by 0.845 for the probable error due to misobservation, etc., (that is to causes independent of the shooting error) $= p_o$, suppose.
7. Then the probable ranging error

$$P = \sqrt{p_s^2 + p_o^2}.$$

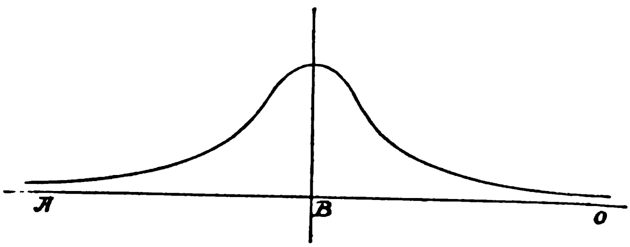
P may be taken at from 25 to 50 yards.

EXPLANATION OF TABLE I.

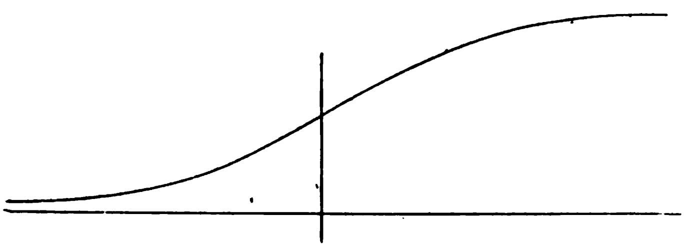
The first three columns of Table I. are taken from von Rohne's Table I. They are easily obtained from any probability table as

explained by the General. The 4th column, V, is the product of the columns c and q, multiplied by 100 for convenience. It shows the probable relative value of a positive round at each division of the scale m, supposing a correction to each division to be as likely as not, or "correct." I have used the term "relative value" in preference to weight, as the latter expression may be required for another purpose.

It is important to realize the conception of V and V'. It is with them that I work. It may be interesting to note the following curves. It is easier to realize V from them than from any wording at my command.

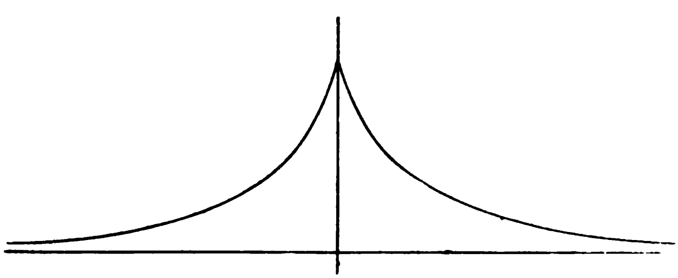


$R =$ the probability curve due to P, the probable error.



Mean point.

$q =$ the integral of the above.



$c =$ twice the integral of R from A to B. $c =$ twice the integral of R from O to B.

V and V' are used as follows: Draw a scale of elevations across the paper, as in Example I, with divisions 12½ yards apart, thus corresponding to the scale m, Table I. Assume a certain number of positives and negatives; enter their values from Table I, as shown in the example, all the positive values (V) on the right of the divisions of the scale, all the negative values (V') on the left; all the 50 values, together with the sign $+$ or $-$, at that division of the scale at which the round was actually fired. Then add up, at each division, the positive and negative values $= \Sigma V$ and $\Sigma V'$, suppose, and that elevation or division will be the most likely at which

$$\frac{\Sigma V}{\Sigma V'} = 1.$$

But it is not always right to correct the most likely elevation. Suppose that at E, the elevation, we have one $\pm$; we know we have a probable elevation error $= P$; and, if we have l $\pm$'s, we have a probable error of $\frac{1}{\sqrt{l}} P$ (see p. 46, Wright's "Adjustments of Observations").

Thus we have

$$m = \frac{1}{\sqrt{l}} P, \text{ or } l = \frac{P^2}{m^2}.$$

I am indebted to Major MacMahon, R. A., F. R. S., for drawing my attention to this law in connection with observations. We see that the amount to correct varies with the degree of accuracy with which the elevation is already known; and that, if that degree has not been obtained, there must be a repetition of rounds at previous elevations till it is attained. To continue:

Imagine the shooting to be taking place at an elevation $E + m$, and that a correction is contemplated to E, there being an excess of $+$'s at $E + m$. At a certain stage it follows that ΣV at $E + \frac{m}{2}$ will equal $\Sigma V'$. When that happens, $E + m$ is as near the most likely elevation as E, and it follows that, before correcting from $E + m$ to E, $\Sigma V - \Sigma V'$ at $E + \frac{m}{2}$ must exceed 0, that is it should $= d$, where d is the difference or excess remaining to be determined.

As, unless the chances are in favor of a "correct" fork, that is unless the odds are even the target is inside the fork, it should

not be split, we arrive at d by the following reasoning: At any distance m from the mean point, $V - V'$ represents the difference d for one round for a correction m; hence for l rounds, the difference $d = \frac{P^2}{m^2}(V - V')$, where m represents the contemplated correction as well as the distance from the mean point.

RULE FOR GIVING A CORRECTION.

Hence we have the rule: Correct from $E - m$ to E, when at $E - \frac{m}{2}$, $\Sigma V' - \Sigma V = d$, and from $E + m$ to E, when at $E + \frac{m}{2}$, $\Sigma V - \Sigma V' = d$. This is fairly simple, especially as, in the majority of cases, it is not even necessary to add, inspection sufficing to show whether $\Sigma V - \Sigma V' = d$ or less. We are now in a position to carry on ranging and some examples will be given.

EXAMPLE I. $P = 25$. d, V and V' from Table I.

Elevations	2000		2025		2050		2075		2100	
No. 1	$V =$			.1	.4	1.6	4.8	12.5	27.1 +	50
No. 2	$V' =$ — 50	27.1	12.5	4.8	1.6	.4	.1			
No. 3		1.6	4.8	12.5	27.1 +	50	46.5	37.5	26.3	16.2
No. 4		1.6	4.8	12.5	27.1 +	50	46.5	37.4	26.3	1.62

REMARKS.

The —'s and +'s are entered under the elevations the rounds were fired at.

After No. 2, at 2025 yards $\Sigma V' - \Sigma V = 12.4 > d = 5.36$.

We therefore correct 50 yards.

After No. 3, at 2037½ yards, $\Sigma V - \Sigma V' = (27.1 + .4 - 4.8) = 22.7 < d = 25$.

We cannot therefore correct 25 yards, viz. to 2025.

After No. 4, at 2025 yards, $\Sigma V - \Sigma V' = 12.6 > d = 3.65$.

We therefore correct to 2000 yards. We cannot correct only 25 yards, for a correction of 50 is due.

Observe the 50 yards fork is not split, after round No. 3. This agrees with General von Rohne's conclusion that such a fork is not "correct," i. e., does not include 50% of the chances. Observe also that we are making no allowance for misobservation when we assume $P = 25$ yards. Thus, it will rarely be advisable to split the 50 yards fork without any confirmation, even under the most favorable conditions as regards laying and observation, and then only provided the target and battery are parallel.

EXAMPLE II. $P = 25$. d, V and V' from Table I.

Elevations	2050		2075		2100		2125		2150		2175		2200
Round No. 1							.1	.4	1.6	4.9	12.5	27.1	– 50
Round No. 2				.7	1.8	4.2	8.8	16.2	26.3	37.5	46.5	—50	
Round No. 3							.1	.4	1.6	4.9	12.5	27.1	+ 50
Round No. 4							.1	.4	1.6	4.9	12.5	27.1	+ 50
Round No. 5					.1	.4	1.6	4.9	12.5	27.1	+ 50	46.5	etc.
Round No. 6					.1	.4	1.6	4.9	12.5	27.1	+ 50	46.5	etc.
Round No. 7	.1	.4	1.6	4.9	12.5	27.1	+ 50	46.5	etc.				
Round No. 8													

REMARKS.

After No. 4, at 2187½ yards, $\Sigma V - \Sigma V' = (3 \times 27.1 - 46.5) = 34.8 > d = 25$. It is clear a correction of 50 yards is not due.

We may therefore correct 25 yards to 2175 yards.

After No. 6, at 2150 yards, $\Sigma V - \Sigma V' = (29.8 - 16.2) = 13.6 > d = 3.65$. It is clear a correction of 100 is not due.

We may therefore correct to 2125 yards.

After No. 7, at 2075 yards, $\Sigma V - \Sigma V' = 1.6 > d = .04$ therefore

We may certainly correct 100 yards; the values of V for the second round are not carried sufficiently far for the system to work, but for all practical purposes, when $\Sigma V - \Sigma V'$ gives a positive or negative result at all values of m included in the Table I., the ranging may be started afresh, that is, the next correction should be equal to our probable error in estimating the range, or, we may keep on doubling the last correction till we obtain a new fork.

EXAMPLE III. $P = 25$. d, V and V'' from Table I.

Elevations	2000		2025		2050		2075		2100
Round No. 1			.1	.4	1.6	4.9	12.5	27.1	+ 50
Round No. 2	—50	27.1	12.5	4.9	1.6	.4	.1		
Round No. 3	1.6	4.9	12.5	27.1	+ 50	46.5	etc.		
Round No. 4	16.2	26.3	37.5	46.5	—50	27.1	etc.		
Round No. 5	1.6	4.9	12.5	27.1	+ 50	46.5	etc.		
Round No. 6	1.6	4.9	12.5	27.1	+ 50	46.5	etc.		
Round No. 7	12.5	27.1	+ 50	46.5	etc.				
Round No. 8	12.5	27.1	+ 50	46.5	etc.				
Round No. 9	12.5	27.1	+ 50	46.5	etc.				
Round No. 10									

REMARKS.

After round No. 6, we have at 2037½ yards $\Sigma V - \Sigma V'' =$ over d which $= 25$.

A glance at 2025 yards shows that a correction of 50 yards is not due.

We therefore correct 25 yards to 2025 yards.

After No. 9, we have at 2012½ yards $\Sigma V - \Sigma V'' =$ over d which $= 25$.

A glance at 2000 yards shows that a correction of 50 yards is not due.

We therefore correct 25 yards to 2000 yards.

EXAMPLE A. $P = 39.2$. d, V and V'' from Table II.

Elevations	2000		2025		2050		2075		2100
Round No. 1	.3	.9	1.9	4.0	7.6	13.4	22.2	34.4	+ 50
Round No. 2	—50	34.4	22.2	13.4	7.6	4.0	1.9	.9	.3
Round No. 3	7.6	13.4	22.2	34.4	+ 50	etc.			
Round No. 4	7.6	13.4	22.2	34.4	+ 50	etc.			
Round No. 5	—50	34.4	22.2	13.4	7.6	etc.			
Round No. 6	—50	34.4	22.2	13.4	7.6	etc.			
Round No. 7	7.6	13.4	22.2	34.4	+ 50	etc.			
Round No. 8	22.2	34.4	+ 50	etc.					
Round No. 9	22.2	34.4	+ 50	etc.					
Round No. 10	22.2	34.4	+ 50	etc.					
Round No. 11	22.2	34.4	+ 50	etc.					

REMARKS.

After round No. 5, a correction of 25 is not due, for $\Sigma V - \Sigma V''$ at 2012½ $= d - 54.6$. This result disagrees with General von Rohne's system to a very considerable extent, it seems.

When we reach round No. 7 we see that the 50 yards fork has to be trebled $\left(\begin{smallmatrix} - & & + \\ - & 50 & + \\ - & & + \end{smallmatrix}\right)$ before it is split.

After No. 11 we should correct to 2000 yards.

$P = 25.$

Some other cases.

Example IV

2000 yards.	2025 yards.	2050 yards.
−		
		+
		−
		+
		+
	−	
	−	
	−	
		+
		−
		+
		+
		+
		+
	±	

Example V

2000 yards.	2025 yards.	2050 yards.
−		
		+
		+
	+	
	−	
	−	
	−	
	−	
	−	
		+
		−

Example VI

2000 yards.	2025 yards.	2050 yards.
−		
		+
		+
	+	
	−	
	−	
	−	
	−	
	+	
	−	
	−	
	−	
		±

Example VII

2000 yards.	2025 yards.	2050 yards.	2075 yards.	2100 yards.	2125 yards.	2150 yards.	2175 yards.	2200 yards.
				+				
−								
		−						
		−						
				+				
			−					
			−					
			−					
				−				
				−				
				−				
				−				
					−			
					−			
					−			
							+	
						+		
						−		

Example VIII

2000 yards.	2025 yards.	2050 yards.	2075 yards.	2100 yards.	2125 yards.	2150 yards.	2175 yards.	2200 yards.
−								
				+				
		−						
		−						
				−				
				−				
				−				
					−			
					−			
							+	
						+		
						+		
						+		
					+			
					−			

Example IX

2000 yards.	2025 yards.	2050 yards.	2075 yards.	2100 yards.
−				
				+
		−		
		−		
				+
			+	
			+	
			+	
		+		
		+		
		+		
		+		
	+			
	+			
	+			
	+			
+				
−				

Example X

2000 yards.	2025 yards.	2050 yards.	2075 yards.	2100 yards.
		+		
−				
+				
−				
−				
	−			
	−			
	+			
	−			
	−			
	−			
		+		
		−		

$P = 25$.

Some other cases.

Example XI

2000 yards.	2025 yards.	2050 yards.	2075 yards.	2100 yards.	2125 yards.	2150 yards.
		+				
—						
—						
		+				
	—					
	—					
	—					
		—				
		—				
		—				
		—				
			—			
			—			
			—			
					—	

Example XII

2000 yards.	2025 yards.	2050 yards.	2075 yards.	2100 yards.	2125 yards.	2150 yards.
		+				
—						
—						
		+				
	—					
	—					
	—					
		—				
		—				
		—				
		—				
			+			
			+			
			+			
		—				
		—				
		+				

Example XIII

2000 yards.	2025 yards.	2050 yards.	2075 yards.	2100 yards.
—				
				+
		—		
		—		
				+
			+	
			+	
			+	
		+		
		+		
		+		
		+		
	—			
	—			
	—			
	+			

Example XIV

2000 yards.	2025 yards.	2050 yards.	2075 yards.	2100 yards.
		+		
—				
+				
—				
—				
	—			
	—			
	—			
		—		
		—		
		+		
		+		
		+		
		+		
		+		
		+		
	+			

Example XV

2000 yards.	2025 yards.	2050 yards.	2075 yards.	2100 yards.
				+
		—		
		—		
				—
				+
				+
			+	
			+	
			+	
			+	
		+		
		+		
		+		
		+		
	+			
	—			

Example XVI

2000 yards.	2025 yards.	2050 yards.	2075 yards.	2100 yards.
		+		
—				
—				
		+		
	—			
	—			
	—			
		+		
		+		
		+		
	—			
	—			
	—			
		+		
		+		
		+		

I have never had this case happen.

TABLE I.

$P = 25$ yards. For use when minimum setting of sight = 25 yards.

c = chance of a round having an error equal to m.	q = chance of a positive round being under each division of the scale m.	m = Yards from mean point.	V = relative value of a positive round at each division of the scale m, supposing a correction to that division to be as likely as not = 100 q c.	V' = do. for a negative round.	$d = \frac{P^2}{m^2}(V - V')$	REMARKS.
.0070	.9965	+ 100	.698	.002	.043	If the minimum setting of the sight were 12.5 yards, the values of V and V' would be calculated for 6.25 yards intervals.
.0182	.9909	+ 87.5	1.8	.016		
.0430	.9785	+ 75	4.2	.092		
.092	.954	+ 62.5	8.8	.42		
.178	.911	+ 50	16.2	1.58	3.65	
.312	.844	+ 37.5	26.3	4.86		
.50	.750	+ 25	37.5	12.5	25.0	
.736	.632	+ 12.5	46.5	27.1		
1.00	.50	+ 0	50.0	50.0	∞	Mean point.
.7360	.368	— 12.5	27.1	46.5		
.500	.250	— 25	12.5	37.5	25.0	
.312	.156	— 37.5	4.86	26.3		
.178	.089	— 50	1.58	16.2	3.65	
.092	.046	— 62.5	.42	8.8		
.0430	.0215	— 75	.092	4.2		
.0182	.0091	— 87.5	.016	1.8		
.0070	.0055	— 100	.002	.698	.043	

Calculated by a 10″ slide-rule.

TABLE II.

$P = 39.2$ yards. For use when minimum setting of sight = 25 yards.

m	V	V'	d	REMARKS.
+ 100	7.9	.35	1.1	This table is merely different ordinates of the same curve as in Table I.
	12.35	.87		
+ 75	17.90	1.9		
	24.3	4.0		
+ 50	31.4	7.6	14.6	
	38.5	13.4		
+ 25	44.4	22.2	54.5	
	48.6	34.4		
+ 0	50.0	50.0	∞	Mean point.
	34.4	48.6		
— 25	22.2	44.4	54.5	
	13.4	38.5		
— 50	7.6	31.4	14.6	
	4.0	24.3		
— 75	1.9	17.9		
	.87	12.35		
— 100	.35	7.90	1.1	
	.15	5.35		
— 125	.05	2.95		
	etc.	etc.		
— 150				
— 175				
— 200			.00	Something very small though not really 0

Calculated by a 10″ slide-rule.

TABLE III.

$P = 25.$

10% misobserved by von Rohne's formula.

[illegible]	[illegible]	[illegible]	[illegible]	
+ 100			.043	
+ 87½	1.61	.2		
+ 75	3.71	.5		
+ 62½	7.95	1.2		
+ 50	14.7	3.0	3.65	
+ 37½	24.2	7.0		
+ 25	35.0	15.0	25	
+ 12½	44.6	29.0		
± 0	50.0	50.0	∞	Mean Point.
— 12½	29.0	44.6		
— 25	15.0	35.0	25	
— 37½	7.0	24.2		
— 50	3.0	14.7	3.65	
— 62½	1.2	7.95		
— 75	.5	3.71		
— 87½	.2	1.61	.043	
— 100				

Calculated by a 10″ slide-rule.

For use when the minimum setting of the sight = 25 yards.

By my system it appears that a single 54.3 fork would be "correct" with $P = 25$, a result about 2 yards greater than von Rohne's and 4½ yards less than Dr. Pochhammer's. When, however, 20 or 30 rounds are expended in ranging, there is no close agreement with von Rohne.

I fear that not being a mathematician I have explained myself very badly and beg to tender my apologies to anyone who has read so far.

Artillery College, Woolwich.
May, 1898.

A HORIZONTAL-BASE RANGE AND POSITION FINDER FOR COAST ARTILLERY.

BY

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In December, 1896, the Board of Ordnance and Fortification made an allotment for the development of a horizontal-base range and position finder for coast artillery. This instrument was completed and installed at Fort Monroe, Virginia, in May, 1896, and has been in use by the artillery troops since that time. The description which follows is a brief account of the development of this instrument.

The desirable and essential features of a good range and position finder might be stated generally as follows: It should be simple, accurate, and reliable, and, as will be pointed out later, should be capable of receiving *protection* against the fire of the enemy.

The instrument now referred to possesses the following features:

a. No electrical parts except a single protected telephone line between the base-ends.

b. No adjustments for variation in the tide, for curvature of the earth, for refraction or temperature.

c. No daily adjustments of any kind required.

d. A base line more than a mile and a half in length.

e. The principle base-end instrument is an emergency depression range finder, to be used in case of need.

f. Can obtain the range of an object easily to within twenty yards in 10,000, or $\frac{1}{5}$ of 1%.

g. Can obtain the range and azimuth directly from any gun selected, as well as from the base-ends themselves.

h. The telescope cross-hairs are illuminated, so that the instrument can be used for night practice as well as day.

i. The range and position finder consists in part of two

accurate azimuth circles, and two telescopes specially designed for the needs of coast artillery.

j. The plotting is automatically made by two massless shadow bands indicating sharply the position of the object at regular intervals.

k. The plotting board presents a full graphical view of the field of fire, showing channel, shore lines, location of mines, etc., in their relative posititions, and enables the commander to predict the future position of any ship selected.

l. The observer at the distant station can be directed to any particular ship selected with sufficient accuracy to prevent delay in identifying the target.

THEORY OF THE RANGE AND POSITION FINDER.

The range and position finder in principle presents an entirely graphical solution of the problem of locating an object. Let A and B, Fig. 1, be the home and distant stations at the extremities of a fixed horizontal base line AB. Let O be an object which it is desired to locate. Let X represent the actual position of a group of guns which is to be furnished with the range and azimuth of the object O. Let XN and ON be geographical meridians. Let B', O' and X' represent the corresponding positions on the map of the distant station B, the object O, and the guns X respectively. The polygon $OBXA$ is therefore similar to the reduced polygon $O'B'X'A$ on the map.

The operation is as follows: An observer at the telescope A keeps it continually pointed at the object O, and by so doing causes a straight radial indicator upon the map to pass through the point O'. An observer at the distant station B keeps his telescope pointed at the object O, and at stated intervals of time previously agreed upon, as indicated upon a chronometer, the observer at B reads the azimuth angle NBO, and telephones the same to a second operator at the home station. This operator, upon hearing the azimuth, sets his circle at B', which controls a second straight radial indicator $B'O'$ upon the map, to read the same as that at B. This operation causes the indicator $B'O'$ to be parallel with the line BO and therefore the intersection O' of the two radial indicators locates the position of the object O upon the map. A mark is made upon the plotting board for the point O' every quarter-minute, or half-minute, as desired, which locates the object O as it moves, and gives an accurate trace of its course.

A range-measuring arm and accompanying azimuth circle are

then pivoted at a point on the map, such as X', corresponding to the mean position of the group of guns X it is desired to serve. The range and azimuth are then read direct from the range arm and circle and then transmitted to the guns. The location of each group of guns, and of the base-end stations themselves, is permanently made upon the map so that, if desired the range and azimuth may be furnished to all groups of guns from any desired point, to be relocated at the guns. It will be noticed that the observer at the telescope A, never makes any readings, his duty being to keep the telescope upon the object O, every quarter or half minute, and let the telescope remain in a fixed position after a setting is made until the recorder upon the board has marked the intersection O'.

One of the special features in working out the practical details of the instruments, is the rapidity with which a setting can be made by telephone and the object O' accurately located. The angle is read at B on a large index wheel and telephoned to B' and a setting made which automatically locates the object in a very few seconds. It would take as long as this to make a setting by a galvanometer, and then, instead of being accurate to a minute of arc, the error of setting would be present.

Points are easily located on the vessel's course every fifteen seconds, though such short intervals are not required in practice. The plotting board easily enables the observer to predict where the object will be at definite stated times one or two minutes in advance of the observations. This rapid manipulation is not due to any special aptitude on the part of the observers, the men operating the instruments in every day practice being non-commissioned officers in the regular service ; but it is largely due to the automatic setting of the radial indicators, which locate the position of the object. These indicators have no mass, and merely consist of beams of light thrown from a projecting apparatus carried upon each axis above the plotting board. On this account it is not possible to introduce error by bending the arms, as frequently happens when mechanical ones are used.

DESCRIPTION OF INSTRUMENTS.

The range and position finder consists of two base-end instruments, located one at either end of a fixed horizontal base line. One of the base-end instruments always has a plotting table as a part of it, and this station may be designated as the "Home Station" in distinction from the other, designated as the "Distant Station," which does not necessarily contain a plotting table. The working efficiency of the range finder,

however, is increased by furnishing both stations with plotting board instruments, so that a separate group of guns can be served from each station. We will describe, however, the Home Instrument with the plotting board and the Distant Instrument without it.

Mounted upon a substantial concrete pier, which is built to the level of the floor of the range finder house, (see description later), stands the cast-iron plotting table *T* (see photographs), which is made at a convenient working height. This table has a large surface, which is machine planed over its entire extent, and has the shape suitable for a plotting board. Its narrowest dimension is about 6 feet, and the longest 9 feet. A person can easily have access to any part of the board, and no injury can be done by sitting or leaning upon it. The table is finished with a special white enamel paint, which may easily be marked upon with a lead pencil, and the marks erased by an ordinary pencil eraser.

The whole instrument, with the exception of the brass work, is finished with olive green paint, and presents a neat appearance.

The scale of the map is 150 yards to the inch, and the table includes distances of 10,000 yards in its smallest dimension. $\frac{1}{30}$ of an inch represents 5 yards on the map, and the range-reading arm is graduated to thirtieths of an inch. Experience has fully justified the use of this scale intermediate between those of 100 and 200 yards to the inch respectively. To include a distance of 10,000 yards makes the table of prohibitive proportions with the 100 yard scale, while, with the 200 yard scale, it is not large enough to give the accuracy required.

The Home and Distant instruments are supplied with similar telescopes, specially constructed with reference to the range finder problem. They have great light-gathering power, due to an aperture of 3 inches diameter, and while the magnifying power is as high as fifteen, the size of the field of view is comparatively large, giving two and one-half degrees by actual measurement. These telescopes are each fitted with means for illuminating the cross-hairs, so that the range finder is ready for use at any time, night or day.

Each telescope is controlled by hand through the handles H_1 or H_2, one for quick and the other for slow motion, which turn the worm engaging the azimuth circle *C*. One revolution of the handle H_2 revolves the telescope through one degree. The index wheel H_1 is divided into 60 parts, which, therefore, register

minutes, one minute being a linear motion of nearly a hal inch on the index wheel H_1. The whole degrees are plainly marked, each having its own number stamped upon it so that no possible error can arise from there being a choice of two readings.

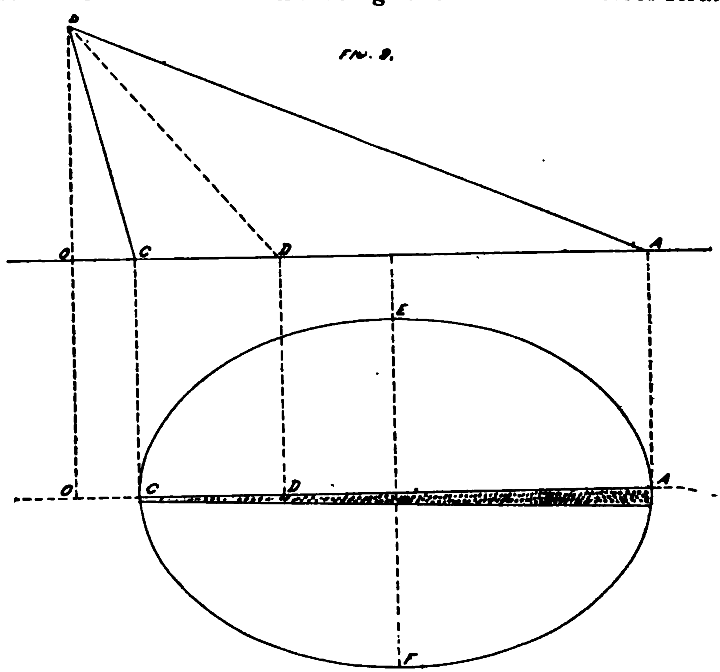
The vertical axis upon which the Home telescope is mounted intersects the plotting board at the point on the map where the Home station is located.

A second azimuth circle is provided at the plotting board, to correspond with the distant circle, and this is operated through the handles J_1 and J_2, one for quick and the other for slow motion, to enable the operator to make a setting by the index wheel J_2 when the angle is received by telephone from the distant station.

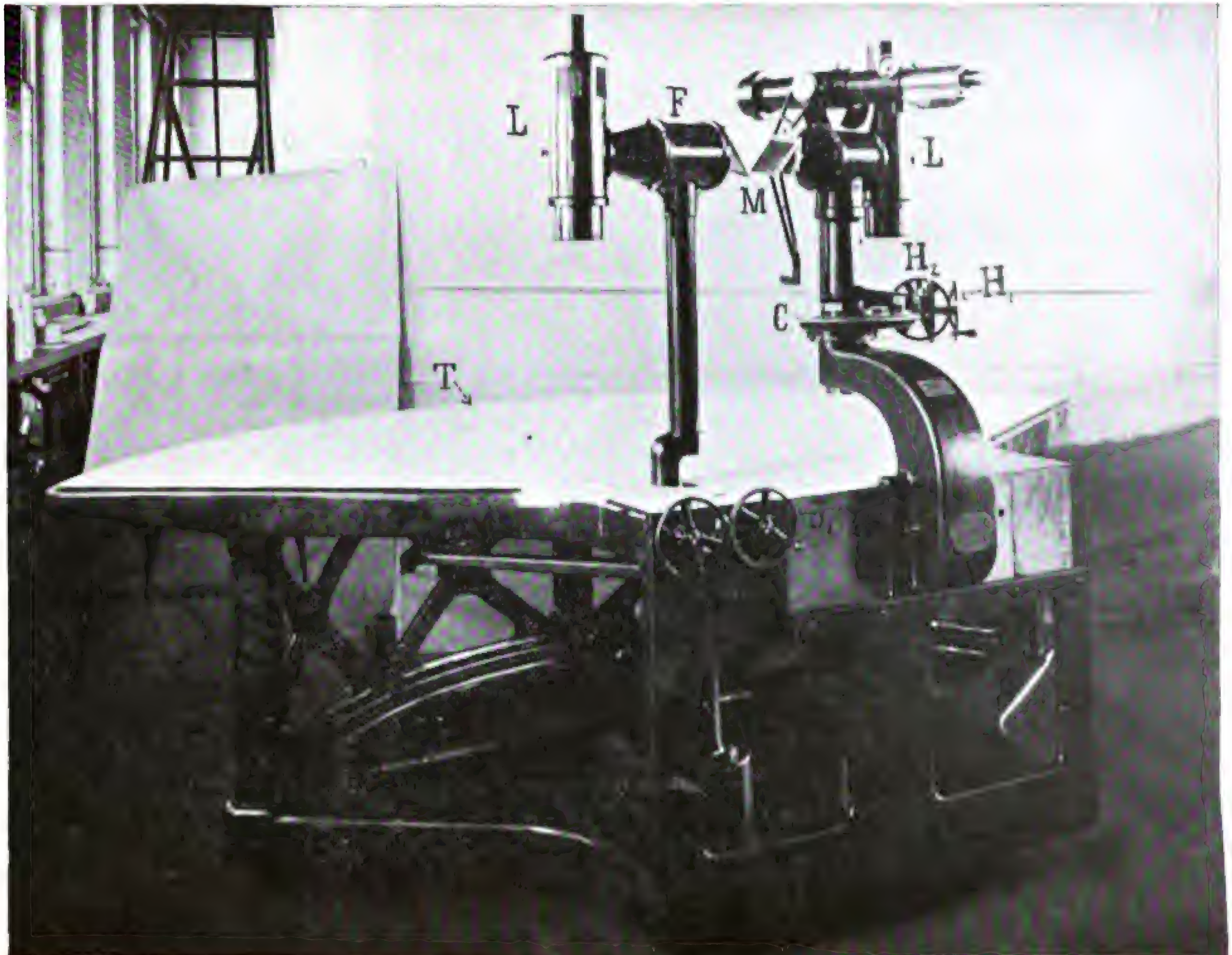
THE SHADOW BAND INDICATORS.

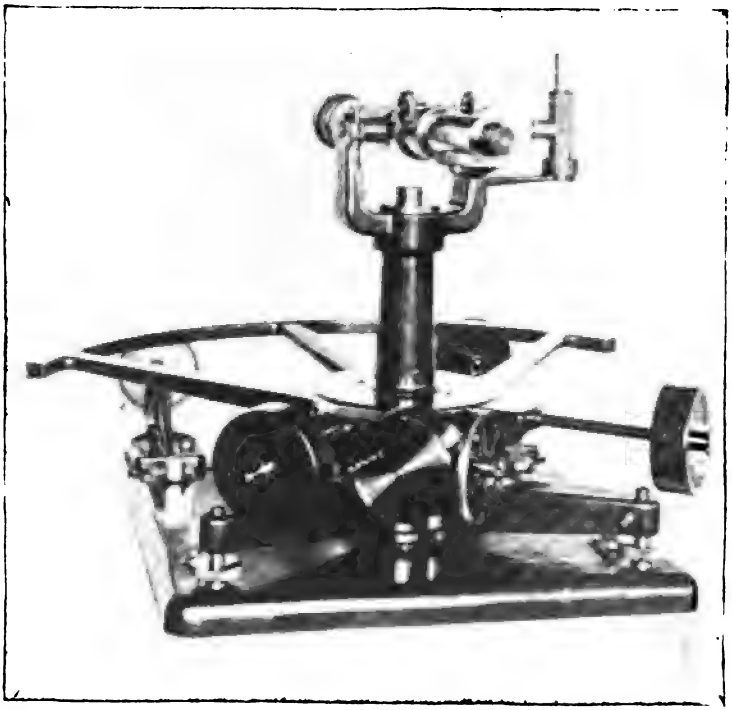
The position of the object to be located upon the map is indicated by two massless radial indicators, which consist of beams of light and shadow. Carried upon each axis corresponding to the Home and Distant stations respectively, is an apparatus for light projection, consisting of a lamp L, condensing and focussing lenses which are enclosed in the brass case F, and a mirror M for reflecting the beam from a horizontal to an inclined position. In front of each condensing lens is a narrow steel straight

FIG. 9.




L
M
F
L
H_1
H_2
C
J_2
T


L
F
M
L
H_2
H_1
C
T



edge, about an eighth of an inch wide, which corresponds to the lantern slide in an ordinary projecting apparatus. and gives upon the screen—in this case upon the plotting table—a magnified image of the steel straight edge.

In Fig. 2 the line OA represents the top of the plotting table, and OB is the vertical axis of the telescope. B represents the origin of a cone of rays CBA, which falls upon the table in a slanting position, the axis of the cone being BD. The plan view of the table with the ellipse CEAF of illumination, is shown in the lower part of Fig. 2, the same letters denoting the same points. The steel ribbon throws its dark image across the center of the ellipse, and is capable of adjustment, so that the line AC may be made to pass through O. The arrangement of lenses and steel strip is also such that the focus may be brought out sharply all along the line AC, at the extreme limit of the board as well as in the nearest position.

To illustrate how well defined the edge of the shadow band is, it will suffice to say that a setting may be made by bringing the edge of the shadow band to a given pencil point upon the table, and a repetition of this operation does not show a variation of a single minute in the reading of the azimuth angle.

Fig. 3 shows a plan of the top of the table with the light from

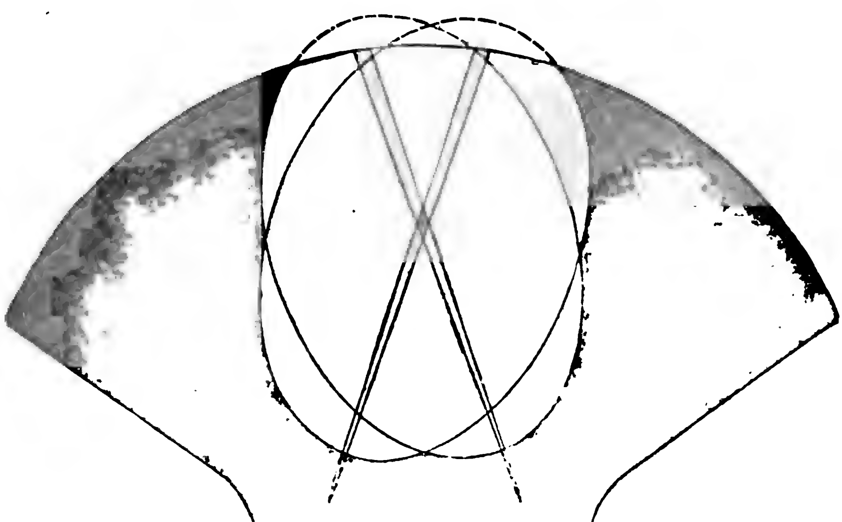


Fig. 3.

the two sources, forming two luminous intersecting ellipses. Where the ellipses overlap the light has double intensity. The two shadow bands show distinctly across the entire board, the greater portion of each band receiving illumination from one lamp only. and so receiving less intense illumination than the neighboring region. Where the bands intersect a dark diamond-shaped lozenge is formed, which receives no illumination from either lamp. The contrast between this dark region and the adjacent doubly-illuminated region is so great that the inner point of this lozenge makes a very accurate indicator.

THE SOURCE OF ILLUMINATION.

The problem of obtaining a satisfactory source of light for the projection apparatus of the range and position finder has been experimented upon, and good results, considering every phase of the question are obtained by the use of an acetylene gas burner.

Oil lamps were tried, and they are furnished with the instrument, but do not give sufficient illumination for the best results. They would do well at night, however, when there is no diffused sunlight to reduce the effect of the artificial light.

Electric incandescent lamps are at present used, and give plenty of illumination and satisfactory results.

The installation in the range finder house of an acetylene gas generator makes the lighting plant self-contained, and with ordinary care the light is always ready for use. A moderate supply of the calcium carbide lasts for months. The character of the acetylene light is also better than the other lights mentioned, as it is more white in quality.

ACCURACY.

While one of the essential requirements for a range and position finder for coast artillery is that the location of objects shall be made with despatch, it should not give second importance to the accuracy of results obtained.

A range finder should be at least as accurate as the accuracy of the guns which it serves demands.

It is believed that this quality is possessed by the instruments now described as used in daily practice. The course of a vessel as plotted always gives such a smooth curve that the points all appear to the unassisted eye to lie upon it. One important quality in the instrument is the fact that it gives such great accuracy at distances of 10.000 yards. It is not an exaggeration to state that a vessel can be as easily located within 20 yards at

10,000 yards distance as it can be located with less accuracy than this.

Observations were taken upon the *Brooklyn* on the day when the "Flying Squadron" left Hampton Roads for Cuba, and her course was plotted with great accuracy to the limit of the plotting board, 10,000 yards. Long before the vessel had reached this distance the water-line and hull had disappeared in the haze. Her flag and masts were the only objects that could be seen through the telescopes.

Since this range finder contains an accurate set of telescopes and azimuth instruments, they are available for the location, planting, and judgment-firing of mines, and for standardizing other instruments which are used.

THE BASE-END HOUSES.

For the mounting of these instruments two protected houses were constructed of concrete, supported by sand in front and finally covered with earth and sod. These houses are each about 18 feet square inside, and have a semi-circular front. Each has a water-tight cellar beneath the main room, for the location of the acetylene gas plant and for storage purposes. The walls of the houses throughout, including the roof, are concrete, two feet thick, and the roof is supported by steel girders. A narrow observation slit, extending around the semi-circular front, is supplied for the use of the telescope. The working room is normally sufficiently darkened to show distinctly the shadow bands used for plotting, but also light enough to see everything plainly in the room.

CONCLUSION.

The subject of a simple, accurate and reliable range and position finder for Coast Artillery is one of great importance. This problem is particularly important to the United States at this time, when a policy of building defenses for our coast cities is being carried forward. No pains should be spared to develop the most efficient of these instruments for installation at the new fortifications.

The experience gained during the past few months should prove of great value to the Coast Artillery, and do much to present the problems in their true aspect, although not a single shot was fired at our coast.

The fact that a Spanish fleet was expected at any time during the earlier period of the war with Spain put a life into the Coast Artillery which is impossible in time of peace. It was this

experience which presented the range and position finder problem in a clearer light.

To take the single case of the new mortar batteries now at several points along the coast, they are practically useless without a range and position finder to furnish the location of the target. Sunken behind immense parapets of sand and concrete, the battery commander can do nothing until furnished the desired information. Furthermore, he can do service only so long during an action as his range and position finder is intact. The moment the latter is disabled or destroyed, that moment his sixteen mortars are out of the fight, and all is confusion. The range and position finding system for such a battery is then more important than any one of the mortars, for the commander loses the use of the whole sixteen the moment it is gone.

From this it logically follows that the range and position finder for such a battery should be *protected* from the enemy's fire, and since upon it depends the use of the entire battery, it should have at least as much protection as the mortars themselves.

This condition of protection for the range and position finder immediately rises to the importance of alone deciding against any instrument for such batteries which cannot receive it.

Again, from the economical standpoint of investing a certain amount of money to ensure certain results, it is economy to invest, if necessary an amount of money equal to the cost of a mortar in the range finder, if thereby any efficiency or reliability is gained for the working of the whole battery. Any commander would rather have fifteen mortars, which he is reasonably certain of, throughout an engagement, than sixteen, all of which may be put out of action at any time by a single shot destroying the range finder. It appears then from a business standpoint alone, that as long as a mortar battery and its armament and ammunition costs what it now does, it is unwise to permit any consideration of cost to stand in the way of the best range and position finder for the purpose, since the most elaborate instrument could not approach the cost of a single mortar, nor indeed the cost of a few rounds of ammunition for the battery.

ENGLISH LIGHT ARTILLERY.

[From *l'Artillerie de Campagne Anglaise en* 1898, in *Revue d'Artillerie*, August, 1898.]

A summary review of the evolution of the matériel.

There are few countries where the matériel of the artillery has undergone so many vicissitudes as in England. This is especially true of the long struggle, hardly yet closed, between the partisans of muzzle loading and those of breech loading. Even yet the military journals sometimes revive this subject with arguments that sound like a lawyer's special pleading—the last echoes of the long discussion, at the close of which England resumed the road which she herself has first opened, but which she had abandoned for fifteen years, while all foreign artilleries had been meanwhile pursuing it.

Without pretending here to analyze the numerous changes which the English matériel has undergone during the second half of the present century, it may, however, be useful to present a summary account of them, especially as a part of the old matériel is still retained provisionally.

1858.—England in 1858 introduced loading by the breech. Cannon of this system, built between 1859 and 1867 on Armstrong's plans were still in 1872 the principal part of the siege and field material. The piece consisted of a tube (first made of rolled iron, then of forged iron, and then of steel), upon which was sunk one or more coils obtained by rolling forged iron bars; the breech screw was hollow and separated from the chamber by a block in which the vent was bored.

The guns of the light artillery during this period were as follows:

Service.	Designation.	Caliber.	Length of bore.	Weight of piece.	Weight of projectile.	Initial velocity.
		in.	cal.	kg.	kg.	m.
Horse batteries.	9-pr. B.L.R., 6 cwt.	3.00	17.5	305	3.8	321
Foot batteries.	12-pr. B.L.R., 8 cwt.	3.00	20.4	406	5.0	377
Camp batteries (heavy)	20-pr. B.L.R., 16 cwt.	3.75	22.3	813	9.5	344

In 1868 the manufacture of these rifled breech-loading guns was interrupted by a movement more and more pronounced in favor of muzzle-loading. This movement was principally due to the accidents that the Armstrong system had met with, the guns showing a deficiency in strength, especially the larger calibers.

1871.—Accordingly in 1871 there was a return to loading by the muzzle. The general mode of construction did not differ notably from the preceding; the hoops were, however, reduced to a single jacket. The following table shows the guns put in service at this time:

Service.	Designation.	Caliber.	Length of bore.	Weight of piece.	Weight of projectile.	Initial velocity.
		in.	cal.	kg.	kg.	m.
Light batteries.	9-pr. M.L.R., 8 cwt.	3.0	21	406	4.4	405
Heavy batteries.	16-pr. M.L.R., 12 cwt.	3.6	19	610	8.0	423
Batteries of position.	25-pr. M.L.R., 18 cwt.	4.0	22	914	11.3	421

1874.—In 1874 a new piece was adopted for the horse artillery, lighter than the one that had been adopted in 1871 for all the light artillery batteries. This diminution in weight was not obtained at the expense of ballistic properties. The ammunition remained the same. The principal elements of this piece are as follows:

Service.	Designation.	Caliber.	Length of bore.	Weight of piece.	Weight of projectile.	Initial velocity.
		in.	cal.	kg.	kg.	m.
Horse batteries.	9-pr. M.L.R., 6 cwt.	3	22	305	4.4	424

From 1873 to 1878 experiments were made with a view to perfect the 9-pr. gun. A 12-pound projectile was adopted, the piece was chambered, the projectile provided with a gas-check, and the cartridge modified. The comparatively good results obtained with the chambered guns retarded the reaction that was now setting in towards breech-loading.

1879.—This reaction eventually led to the adoption in 1879 of a new gun, breech-loading and chambered, the 13-pr. B.L.R., 8 cwt. This was a marked improvement upon the guns then in use. The mode of construction was the same, but a better form was given to the chamber and the rifling, and the length of bore was increased to 28 calibers.

But this new piece was to have but an ephemeral existence. Hardly were the first of these 13-pr. guns put in service, when it was decided to finish the numerous guns of this kind, then in course of construction as muzzle-loaders. No other alteration was made in the design of the gun.

Service.	Designation.	Caliber.	Length of bore.	Weight of piece.	Weight of projectile.	Initial velocity.
		in.	cal.	kg.	kg.	m.
Light batteries.	13-pr. M.L.R., 8 cwt.	3	28	406	5.7	486

The heavy batteries of position preserved the armament adopted in 1871 (16, 25 and 40-pr.).

Despite the undisputed advantages that the 13-pr. gun had over the unchambered 9-pr. piece, the transformation of the armament progressed very slowly. Doubtless this was due to the studies then in progress in regard to breech-loading, a principle that by this time could not be ignored.

1883.—Finally in 1883, after many trials, England adopted breech-loading for all of its artillery, using the French screw and the De Bange obturator; at the same time the method of constructing the hoops by coils was given up, and cast steel was adopted for the hoops as well as for the tube.

The 12-pr. field gun, model 1883, built in this way, constituted at the beginning of 1895 the larger part of the armament of the light batteries.

A 20-pr. gun made in the same way was tried a little later and provisionally adopted in 1889. This was intended to replace the old 16-pr. gun for the heavy batteries and batteries of position.

The following is then the armament of the light artillery from 1883 to 1895, not taking into account the old models of 16-pr., 9-pr. and 13-pr. guns that were still kept provisionally in service:

Service.	Designation.	Caliber.	Length of bore.	Weight of piece.	Weight of projectile.	Initial velocity.
		in.	cal.	kg.	kg.	m.
Light batteries.	12-pr. B.L., 7 cwt.	3	28	356	5.7	524
Heavy batteries.	20-pr. B.L., 12 cwt.	3.4	29	610	9.3	510

The adoption of the 12-pr. gun brought about (omitting the old models) not only unity of caliber but *unity of piece* for the horse and for the field batteries.

A similar tendency had several times before manifested itself in the English service; in 1871 by the adoption of the 9-pr., and in 1879 of the 13-pr. As we have seen, the first of these changes was followed in 1874 by the introduction of a lighter piece of the same caliber for the horse batteries.

A similar fact was not slow to follow the adoption of the 12-pr. model 1883. This gun was soon objected to on the grounds that it did not give complete satisfaction to either of the two artilleries; it lacked mobility for the horse artillery and power for the field artillery.

Hence there arose two series of experiments on different lines. Following the first of these, there have been tried since 1888 a piece of 6 cwt., a wire-wound gun of 5¾ cwt., a rapid-fire gun, a piece designed to fire cordite, and finally in 1896 a wire-wound gun of 6 cwt.

In the second line of experiments, the 12-pr. model 1883, with some modifications, has been retained for the field artillery with the weight of the projectile increased to 15 pounds.

Last of all a 5-inch howitzer, weighing 450 kg. (1000 pounds), has been adopted after many trials.

At the close of 1897 the horse batteries for the most part were armed with the wire-wound gun of 6 cwt. and the field batteries in the interior furnished with the 15-pr., excepting two, which have received the 5-inch howitzer.

1898.—Definitely then, the armament of the light artillery properly so-called is at the present moment as follows:

Service.	Designation.	Caliber.	Length of bore.	Weight of piece.	Weight of projectile.	Initial velocity.
		in.	cal.	kg.	kg.	m.
Horse batteries.	12-pr. B.L. wire gun, 6 cwt.	3	20.0	324	5.7	473
Field batteries.	15-pr. B.L. gun, 7 cwt.	3	28.0	360	6.4	480
	5-inch B.L. howitzer, 8 cwt.	5	8.4	480	22.7	240 (max. charge)

The military publications are silent as to experiments that may have been made with rapid-fire matériel. Similar secrecy has been preserved in regard to experiments with high explosive projectiles; all that is known is that the explosive employed in these experiments, lyddite, is composed chiefly of picric acid.

Heavy Batteries.—The 20-pr. gun mentioned previously as having been put on trial in 1889, and intended for the heavy field batteries, seems to have been abandoned.

On the other hand, a gun of 10 cm. (3.94-in) caliber, firing a projectile weighing 30 pounds with a velocity of 495 m., was adopted in 1897. The piece and the caisson equipped weigh without cannoneers respectively 2685 and 2557 kg.

These last two guns, properly speaking, do not belong to the light artillery, but it seemed worth while, however, to mention them, as they throw light on the solution that England appears to be making of the problem of heavy artillery.

Retention in service of guns of old models.—In terminating this brief historical review, it will be well to observe that the adoption of new guns from time to time has never brought about the entire abandonment of guns of earlier models. So even now in official publications, we see various models of the old muzzle loading guns figuring as part of the guns now in service. The drill manuals for the 16-pr. and 9-pr. have recently been re-edited (1895), with no restriction laid down as to the employment of these guns.

The fact is that the 16-pr. pieces were in the main distributed to the "volunteers" in 1892. The 9-pr. and 13-pr. were the armament of the batteries in India up to 1890; at this time the distribution of the 12-pr. guns to these batteries began, and the transformation was to have been completed in 1894. On the

whole, whatever may be the exact use that the old muzzle loaders are now put to, we feel authorized in believing that in time of war they will have quite a secondary rôle.

E. ROLLIN,
Captain of Artillery.

[Translated by GEO. BLAKELY, 2nd Lieutenant, 2nd Artillery.]

INSTRUCTIONS FOR REPULSING ATTEMPTS AT LANDING BY NORTH AMERICAN EXPEDITIONS ON THE COASTS OF CUBA.*

ARMY OF OPERATIONS IN CUBA.
GENERAL STAFF.

CONFIDENTIAL CIRCULAR.

Although I am fully convinced of the competency of all the generals and officers of this army, of their skill in the service and their tactical knowledge, as well as of their bravery, energy, and decision in battle, I deem it proper to publish some instructions for the best way, in my judgment, of combating the American army on the day when it proposes to invade the territory of this island. I hope these instructions will be carried out and supported by every one in the part which concerns him. They are as follows:

I. WATCHING THE COAST.

The lookout service will be carried on as heretofore, combining its good performance with the preservation of the health of the soldier, without fatiguing animals or tiring out the troops. The latter should be often relieved and given natural hours of rest, that they may increase in proficiency. The service should be so arranged as to be in operation at all moments and at all points of the coast that are to be watched. The forces of each brigade must be in touch with those on the flanks with mounted messengers between them. It must be understood that one of the most important things is to know immediately the spot where the landing of the enemy is being attempted, in order to accumulate forces there and prevent it. This end will be much served by strongly occupying high places which are already marked in each zone; these may be called observation points, from which may be taken at a glance large stretches of the coast and many miles of the sea in front and on the flanks; thus the nearest commander of a division, brigade or column can be informed of the point for which the transports and ships of the American squadron are seen to be heading in order to attempt a landing.

* Translated from a copy of the circular found in the archives at Trinidad.
* Through the courtesy of Bureau of Military Information, War Department. Published by permission.

II. ATTEMPT AT LANDING.

The commander of the force who receives the information will move rapidly with as many troops as he can assemble, toward the point selected by the enemy to make a landing. He will choose positions in which to fortify himself, construct trenches of the kind called Carlistas, having them as well hidden as possible so as to keep his flanks covered, the trenches being defiladed from the hostile squadron and so placed that they cannot be used by the enemy if we have to retreat.

The order of battle will be open, of small depth, with supports and reserves posted in places sheltered by the terrain, so that the enemy's artillery will do the least possible harm. Positions will be chosen so as to be as much hidden as possible from the sea, having a command for front or direct and for enfilading fire over the beach and over as large as possible an expanse of the sea, so that the fire may be as close and effective as possible upon the launches used for landing. Firing will be continued without interruption, for which purpose the combatants will be relieved at suitable intervals; it will be begun as soon as the launches are within rifle range, and will be supplemented by the fire from mountain pieces.

Commanders of columns must be impressed with the necessity of going without losing an instant's time to the place where the landing is being attempted, so as not to give the enemy time to intrench himself or make other suitable disposition for the combat.

III. MOMENT OF LANDING.

If in spite of the great amount of firing done at the launches a landing should be made, which is not probable, then a bayonet charge will be made with all impetuosity, this charge being preceeded by two or three solid volleys, so as to drive the enemy back to sea, carrying confusion into their ranks and preventing the disembarkation of animals, material, and other warlike stores; this volley may be made without fearing fire from the squadron, which cannot open for fear of wounding some of its own men, and will undoubtedly produce decisive effects.

In this phase a brilliant use may be made of the cavalry, if the lay of the ground permits it.

IV. THE LANDING A FACT.

If in spite of everything the enemy is not forced to re-embark, there will be in rear a second line of positions, arranged like the first, with flanks well covered, so that they cannot be turned by

the enemy. To this end all accidents of the terrain will be utilized, so as to combat the enemy to advantage and prevent his getting established, it being constantly borne in mind that he is never to be given a moment's rest. From front and flank guerrillas and irregular mounted forces are to be thrown out against him, supported by the fire from our infantry and mountain artillery. The service of relieving combatants must be well organized, so that the enemy may be allowed to neither rest, eat nor have a moment's peace. Troops going to prevent landings will carry three days' rations. During these two phases of the operation the Americans must be fought with genuine fury in order to make them re-embark at any cost.

As soon as the place of landing is known, all cattle and other means and resources which are found will be sent one-half day's journey to the rear; detachments will be ordered to withdraw from points where they are not indispensable to the maintenance of the line of operations, the places abandoned being burned, as well as all towns, hamlets, huts, etc., and everything the enemy might utilize for shelter; everything of leguminous nature will be pulled up by the roots and every life-sustaining element will be destroyed and all cattle which cannot be gathered in herds will be killed, all with the understanding that the enemy shall find nothing but ashes.

Families will be collected together and taken to the rear of the columns. American prisoners will be brought, suitably guarded. to Habana, where it will be decided how they are to be treated, and insurgents will be subjected to most summary trial and sentence l according to the Code of Military Justice.

In case the landing has become a fact, the campaign will assume a definite aspect and will be suitably directed by the respective generals, who must adopt the system of continually harassing the Americans in their marches and camps. Field officers will endeavor by all means to be always within reach of the hostile forces and not allow them to advance, and will fortify themselves in advantageous positions in expectation of reinforcements which will be sent immediately.

Besides the prescribed rules, each brigade commander will give for his brigade such directions as he believes suitable for the better success of the operation, always submitting them to the approval of division commanders, who in turn will submit them to corps commanders, the understanding being that the aim of all must be at any cost to prevent the enemy's landing; to this end, and to restrain him in his advance, should he land,

they must direct all their efforts, hoping that by their bravery and skill, as well as their zeal, patriotism, and good will, they will outdo themselves in the fulfillment of their duty. Thus will the invasion of our boastful enemy be gloriously repelled.

Habana, May 24, 1898.

BLANCO.

[SEAL]: { Ejercito de Operaciones. E. M. G. CUBA. }

THE NEW FIELD ARTILLERY.

(From an article in the *Revue de Cavalerie*, with additions from other sources.)

All the Powers are now transforming or have in view the transformation of their field artillery. Trials with rapid-fire guns are taking place in all parts of the world. Artillerymen have made of it one vast proving ground, as it were, and every day brings forth new firing trials.

A complete study of the new artillery is a somewhat dry subject, but it is one that concerns all future combatants. Moreover, every one is now interested in military affairs, and national defense engages the attention of the least belligerent minds.

The origin of the new guns is as follows: When breech-loading, high-power steel cannon of the Krupp, de Bange systems, etc., were put in service, it was at once recognized that they possessed the following advantages:

The use of a metal of greater strength than bronze; remarkable power and great accuracy; and easy service, thanks to the breech mechanism.

But now, more conditions are required to be fulfilled. Great progress has been made in the science of explosives and in the manufacture of steel. Slow burning, smokeless powders give with relatively low pressures initial velocities that were not dreamed of several years ago. As to steel, its limits of rupture and of elasticity, which were about 62 and 32 kilogr. respectively, are now 74 and 47 kilogr. Moreover, for carriages, plates are now manufactured that, with a thickness of 5 mm., enable the same results to be secured that could only be obtained with plates of 9 mm. Hence we have the material for the construction of guns than shall be both powerful and light. Tacticians and experts are in accord on the point that field artillery, distanced by the infantry small arm, ought to be improved* to meet modern requirements and should consist in future only of pieces possessing the following advantages:

Mobility carried to its extreme limit.

* It will be recalled what an impression was made at the close of 1891, by the pamphlet of General von R. Wille on "The Field Gun of the Future" and by a second work by the same author: "The Cannon of the Future". General Langlois, in his writings as also in his lessons at the War College, has also treated the subject of rapid-fire artillery in a masterly manner.

Finally, at a meeting at Saint-Chamond, Adrien de Montgolfier, a former pupil of the *Ecole Polytechnique*, made some striking remarks on rapid-fire artillery and its rôle in the future, which attracted much attention.

Useful effect equal to at least that of the best gun of the present.

Suppression of recoil.

Rapid fire.

As the result of many experiments and trials, cannon have now been produced approaching the desired ideal.

Before going further, however, it becomes necessary to understand the expression "rapid-fire". Some claim, what ought to define rapid-fire is the existence of a carriage that absorbs all recoil and reduces the aiming of each round to a small correction quickly given during the loading of the piece ;* and only those are rapid-fire guns which have no recoil and the aiming of which can be done once for all rounds.†

Others reply, a gun may quite well merit the designation of rapid-fire even though it may have some recoil and may require, accordingly, a rectification in the pointing. This term should be applied no matter how little the necessity of running the piece "in battery" again is avoided after each round; if in any degree correcting the aim may always be easily accomplished; and when, under these circumstances, a rapidity of several shots per minute may be practically obtained.‡ Of these two definitions, the second generally prevails.

Among the manufacturers, some have lightened the weight of pieces, others have produced heavy guns. Let us first consider the light matériel.

The new field piece and carriage (gun, carriage and limber together) does not exceed 1800 kilogr. in weight, so that mobility, one of the indispensable requisites of field artillery, is assured. A piece weighing 1800 kilogr. can climb a hill, can traverse ploughed or swampy ground and cross gullies and ravines. On firm and level ground with the cannoneers seated, it can be drawn at a trot or gallop by six horses of medium strength, as horses usually are after a few days of field service. In cases of necessity it can be drawn by four horses.

The calibre of the new pieces is 75 mm. (2.95 inches). This reduction of calibre has made the rapid-fire question easier of solution, for the larger the calibre the more difficult the problem. This reduction is the result of high initial velocities now realized, so that with relatively light projectiles, sufficient destructive effect is obtained. Progress in ballistics has led also to the use

* Captain Moch.

† Colonel de Bange.

‡ *Journal des Sciences Militaires.*

of longer projectiles and has tended to give considerable weight to those of smaller diameter.

It has not been thought advisable to go below 75 mm. for then efficacy of fire is considerably diminished. A very small projectile does not contain enough balls and its point of burst cannot be observed with exactness.

For tactical reasons, the length of the piece can not be too long. It must be such that the piece can be easily maneuvered.*

The new projectile weighs from 5 to 6 kilogr. There are two kinds, one, shrapnel of the usual form and construction, containing from 150 to 250 balls with base bursting charge; and high-explosive shell for use against obstacles. The efficacy of the second is limited, however, by its small capacity.

This general transformation of matériel has presented the opportunity for making many modifications as regards better means for ammunition transport. The dead weight of the old carriages constituted an enormous percentage of the total weight transported. The new matériel, although much lighter, is as strong as the old.

To make a light gun has offered no difficulties and the problem of a new field artillery would have been solved long ago if the quasi-impossibility had not been encountered of constructing a carriage, suppressing the recoil of the piece. Up to the present time, inventors have produced two types: one, the extra-rapid, firing as many as 25 rounds per minute; the other, limited to 10 to 15 rounds per minute. If rapidity of fire were the only thing to be considered, the choice would be easy, but in addition to that, precision is essential.

Two systems of carraiges have met with favor. One immediately absorbs the force of recoil by becoming fixed in the earth by means of a trail spade and by bringing into play certain resistances due to friction. The other system consists in the use of a movable upper carriage on a fixed chassis. Springs, suitably arranged, gradually absorb the recoil and then by recuperation, bring the gun back to its former position.†

Ordinarily, after each round, rectification of the aim is necessary on account of the slight but unavoidable displacements. The correction is made in the twinkling of an eye, and expert cannoneers can, in a minute, cover their first hit with a dozen others.

* A gun 2.8 m. long like that proposed by General Wille, would be a serious obstacle on the march in difficult country.

† Hydro-pneumatic "brakes" or cylinders and similar appliances for absorbing the recoil, are included in this type.

For the charge, the metallic case is generally used. Some inventors retaining the de Bange obturator, make use of a cartridge with a combustible case. This adds no extra weight in transport, is of no inconvenience on the battle field and is of moderate price.

Military publications are silent as to the matériel adopted in their respective countries. We have to confine ourselves to mentioning the principal systems.

In England, Armstrong has constructed the pieces destined for the British forces.* Much discussion has taken place among the English as regards the advantages and disadvantages of rapid-fire artillery, but its merits and the necessity for it, in view of the arming of foreign armies, are now fully recognized.

In Germany, Krupp has developed a complete rapid-fire matériel, the merits of which have been described by German writers. It has already been distributed to a number of the army corps. According to the *Frankfort Gazette*, this new piece fires 10 rounds a minute with corrected pointing, and has a range of 8,000 metres. A large spade on the trail buries itself deeply in the ground after the first round, and this with certain other arrangments not yet made public, check the recoil. The gun is of nickel-steel, calibre 75 mm. It is 2.15 m. long and weighs 410 kilogr. without the carriage, or 30 kilogr. less than the old model. The breech-mechanism is very much like that of the Krupp guns; a prismatic block moving in a horizontal plane. The cartridge is enclosed in a metallic case which is fixed to the projectile. Firing is effected by a firing pin striking a cap fixed in the center of the of the end of the case. The round having been fired, the case is ejected automatically by the single motion of opening the breech.

In Belgium, the Cokerill works of Seraing, near Liege, have produced the improved Nordenfeld guns. In Austria, the Skoda works at Pilsen; in Russia, General Engelhardt, one of the foremost artillerymen of the times; in Switzerland, Lieutenant-Colonel Payan; in Italy, Rear-Admiral Albini; in Spain, Sotomayor and Ordoñez; in Mexico, Lieutenant Colonel Mondragon,† have invented and produced remarkable types.

For the past five years, the French government has been making experiments with rapid-fire field pieces. These experiments have been secretly carried on and the fabrication of the French

* This matériel calibre 57 and 84 mm. as well as the 75 mm piece, Nordenfeld system has been most thoroughly studied and described by General R. von Wille in his *zur Feldgeschutzfrages*.

† The Mondragon gun, invented in Mexico, is constructed in France.

rapid-fire gun has taken place with the greatest possible secrecy.* The new field piece, caliber 75 mm., is entirely of nickel steel and has the usual breech-closing mechanism. The piece is sighted and fired by a man who sits at the side of the gun carriage. The finer adjustments of traversing are made by turning the gun itself on the carriage. When a projectile is discharged from the gun, the carriage shows a tendency to recoil which is counteracted by a spade secured to the rear end of the trail. By embedding itself firmly in the ground, the spade prevents the carriage from changing its position. The gun slides back on the carriage but is returned to its initial position by a recoil-cylinder. Ordinarily the gun can fire five shots per minute, and if ammunition be served quickly enough, twenty shots per minute. Fixed ammunition is used. The projectiles are explosive shell filled with melinite and double fused shrapnel containing about 250 lead balls. Two shields, one on each side of the gun, protect the cannoneers. The gun has a preponderance, the gun-carriage is longer and the distance between the gun-wheels and those of the limber is greater than in the old model. The caisson has but two chests. Both these and the gun are set low. All the carriages are painted grey-blue.†

It may be added that the French gun tends to realize unity of caliber at least in the field artillery in present use.

It has been deemed not at all necessary to construct a piece intended for the batteries attached to cavalry divisions. The new gun, weighing no more than the 80 gun, de Bange system, should answer all requirements. The objection has often been made that 1800 kilogr. are a very heavy weight for the guns of horse batteries. But this inconvenience will be largely offset by the advantage of easy replenishment of ammunition; these batteries attached to the cavalry, cannot carry a reserve train with them, but they can readily replenish their ammunition if they fire the same projectiles as the batteries attached to the infantry divisions. Moreover, the cannoneers are mounted, hence there is a great difference as regards the weight transported and the facility in maneuvering between these batteries and those with the infantry where the cannoneers are on the chests.

* The method employed with the greatest success at the present time is that called *compartiments isolés*. It consists in distributing the parts to be manufactured among various shops and in several localities. The assembling and mounting of the piece is then entrusted to reliable men. Secrecy of manufacture is thus maintained for some time against any system of espionage.

† *Journal of the Military Service Institution.*
Eight of these pieces appeared at Châlons at the September maneuvers. They were divided into two batteries, and it is claimed that four is henceforth to be the usual number of guns per battery, both on a peace and war footing. It is further stated that four of the new guns are much more deadly in their effects than six of the older and larger models.—*Id.*

France is fortunate in the possession of several manufacturing establishments where some of the finest types of rapid-fire artillery are at present produced. At the Creusot works, two types of rapid-fire matériel of the Schneider-Canet system are constructed.*

This system comprises many types of light and heavy rapid-fire guns.†

A rapidity of 10 to 12 shots per minute with correction of aim after each round has been obtained. They are extremely accurate guns and their performance has always been excellent, both in the course of ballistic firing and in rapid-fire trials. A great many Schneider-Canet field guns have been made for foreign governments.

The Darmancier gun—now undergoing trial in Russia, Switzerland, Spain, Portugal, Mexico and Japan—is made at Saint-Chamond. As regards the superiority of this matériel over the steel guns now being rapidly superseded, it was concisely defined a few months ago as follows:

"Due regard being had for the total weight, gun and carriage, when the energy impressed upon the projectile is considered, also the rapidity of fire, this matériel is found to possess, with equal weight, an offensive power fifteen times greater than that corresponding to the best piece (de Bange, Krupp, etc.), now in service." ‡

This establishment has also designed a carriage giving the greatest rates of fire obtained at present in Europe. A rate of 14 aimed rounds per minute was easily obtained, the fuzes having been previously set for the range when using shrapnel. But they have gone even further and obtained a rate of 25 rounds per minute from this mounting.§

The new heavy field gun has given rise to heated discussions. Some urge a reduction of caliber and hence a diminution of the weight of the machine, (this tendency towards lighter and hence more mobile guns always asserts itself after periods of prolonged peace); others, on the contrary, insist on the maintenance of large calibers and an increase in the weight of projectile, with the view of increasing the man-killing effect as well as obtaining the advantages of curved fire. The latter makes it possible to reach the enemy sheltered behind his entrenchments.

* The *Revue d'Artillerie* has published the results of experiments made with the Schneider-Canet gun. General Wille, in his *zur Feldgeschutzfrages*, also speaks of it enthusiastically.

† *Journal U. S. Artillery*, Vol. VII, No. 3.
Messrs. Schneider & Co.'s works at Creusot. *Engineering*, 1898.

‡ *Memorial de la Loire.*

§ *Journal Royal United Service Institution.*

The advantages of a heavy gun consist, from a moral point of view, in a sort of affirmation of the spirit of the offensive and the determination to win; from a practical point of view, in the possession by the commander of a means of rapidly bringing on the final result. By the destructive effects of their projectiles, heavy batteries produce a shock that cannot be obtained in any other way.* In the case of shell charged with melinite and other high explosives, the remaining velocity of the projectile plays an insignificant rôle compared to the destruction produced by the liberation of such a large volume of gas as results from the explosion.

In Germany, the advocates of heavy artillery have based their most decisive arguments on the probable character of future struggles where their forces will be obliged to proceed against fortified places or troops holding strong positions. The German heavy batteries were at first designed solely to act against permanent works or field fortifications. But after mature consideration, the program was enlarged. Placing themselves under the conditions of active, vigorous war, the General Staff, at Berlin, have decided that large calibers are a necessary element of the army, independently of all details of the theatre of operations.†

The English adopted, in 1897, a 10 cm. (3.94-inch) gun, firing a projectile weighing 30 pounds with a velocity of 495 m. The piece and the cassion equipped weigh respectively, 2685 and 2557 kilogr. without the cannoneers. There are also some English field batteries equipped with a 5-inch B. L. howitzer, weight of projectile 22.7 pounds. with a maximum velocity of 240 metres.‡

The Russians have organized some heavy batteries entirely distinct from those of the fortress artillery, and seven regiments of field mortars 15 cm. in caliber.

In Austria there have been organized, in case of mobilization, groups of batteries called mobile siege batteries, the personnel of which is furnished from fortress troops and the teams from the artillery train.

Switzerland and Turkey also have position batteries.

In France the artillery matériel has been increased by a piece called, according to official nomenclature, "*120 court*" (120 mm.

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* In 1870, at Coulmiers the 12 cm. rifled guns placed in line in preference to the 4 cm. ones which had produced almost no effect whatever in the battles around Metz and Sedan, surprised and demoralized the Bavarians by their effective and heavy fire, and resulted in giving the French a well marked victory.

† The German artillery is about to receive a howitzer of 15 cm. caliber which will replace the 12 cm. piece of hardened bronze with central tube of nickel-steel.—a type now out of date.

‡ *Revue d'Artillerie*, August.

caliber, short cannon). This gun was put in service in the beginning of 1894, forming two batteries of each corps regiment or 38 batteries. Some of these have taken part in the artillery maneuvers at Châlons and also in the Grand Maneuvers of 1895, 1896 and 1897.

The gun is 1.7 m. long. Its weight is 690 kilogr.: that of the carriage 785 kilogr. and limber 890 kilogr., which makes a total weight of 2365 kilogr. It throws two kinds of projectiles: shrapnel, with base charge, model 1891, weighing 20 kilogr., and an elongated shell filled with melinite used for battering and, especially, great explosive effects. The rate of fire of the *120 court* can hardly be called "rapid," but rather "accelerated."

To be sufficiently mobile and effcient, that is to say neither too heavy nor of too small a caliber, the field howitzer should not be much more than 12 cm. in caliber nor less than 10 cm.*

In order to have ideal mobility, heavy artillery should look to automobilism. Mechanical draught is progressing with gigantic strides and the utilization of it for military purposes is now being seriously considered. Evidently, a strong and easily maneuvered automobile that could go at a good rate of speed as well on grades as on level ground, would do away with the necessity for all horses or teams with their huge supply of forage. One expert motorman would suffice for the care of the machine and for running it on the march. The distance gained by having no horses would greatly reduce the length of columns or permit the use of a greater number of pieces.

Grand-duke Wladimir of Russia, who has studied the application of automobilism to the transportation of the Russian artillery proposes to retain the teams as mounts for the cannoneers and as auxiliaries in difficult places and in special evolutions. According to his plan, going into battery on the field of battle will be performed in case of need with the aid of horses, but on the march, pieces and caissons will be drawn by the gun-limber motors. In this manner the number of animals will be greatly reduced, at the same time those retained will be spared much work.

In England, similar views are held by a number of officers, and the question has been the subject of several important conferences.

Experiments with military automobiles have taken place in

* The Creusot works have produced a rapid-fire field howitzer, caliber 120 mm., which throws a 20 kilogr. projectile with an initial velocity of 280 metres. The charge of BN powder, weight [illegible] kilogr., is enclosed in a metallic case attached to the projectile. The piece is capable of high-angle fire at angles between [illegible] and [illegible] 45°. The gun, carriage and limber (containing 18 rounds) weigh 2100 kilogr., and is drawn by six horses.

France since October, 1897, under the auspices of a technical commission. The trials have been rigorous, thorough and satisfactory. In the vicinity of Paris the Scotte train particularly has been experimented with. The public has been enabled to see a Scotte train rapidly draw caissons loaded with projectiles to the forts of the left bank of the Seine, between those of St. Cyr and Palaiseau, and surmount, without the least mishap, the most rapid ascents. The same automobile has drawn also, with marvellous facility, some of the largest siege pieces.

Colonel de Bange and Captain Marin have good authority, then, for the statement that, in the near future, artillery will possess some powerful means of transport due to automobilism.

In some countries, as Italy, where, in case of mobilization, recourse must be had to oxen for the transport of supplies, automobiles will simplify and assure the operation.

As a result finally, with very strong machines, the weight of field pieces, which to-day has an extreme limit of 2500 kilogr., can be greatly increased,—in fact, doubled. The time is coming when automobilism will be applied to the transport of heavy matériel. Mechanical traction, promises of which are now being realized, is the hope of those who put the future of artillery not in its lightness but in its power.

As soon as the pattern of the new gun was decided, the question of its tactical employment came into prominence. The new gun combines a greater effect of the single shot with a greater state of preparedness. The question of its employment, and of the organization of the field artillery, which is closely connected with this, can be answered in two ways, according as a greater value is attributed to quiet, well-directed fire, that is to the effect of striking the target, or to a greater quantity of rounds being fired in a short time—that is, to the greatest possible rapidity of fire.

The advocates of quiet, well-directed fire, with observation of each shot, desire strict centralization in the hands of the battery leader, which is only possible with sub-division fire; this view, therefore, points to the necessity of reducing the number of guns in a battery from 6 to 4. This alone can secure the greatest use of the power of the gun, quiet service aud sufficient ammunition supply. For in a battery of 4 guns, each gun can be provided with a greater number of rounds than in a battery of 6 guns without an increase in the number of ammunition wagons. But if the best value be attributed to the highest development of rapidity of fire, this must necessarily lead to a change in the

method and order of firing. Some advocate the ranging being carried out as now, and after it is completed would employ rapid-fire. Others would leave the ranging to the observation of the sub-division leaders and only fire by sub-divisions; a third party advocate the omission altogether of systematic ranging, and by means of rapid-fire, would search an area of the breadth of the battery and 1000 metres deep, on the assumption that the target within this area must inevitably be struck.

The question of the bombardment of covered objects by the artillery has entered a new stage since the introduction of the new gun. This new gun has, in a greater degree than the old one, the character of a flat trajectory gun, so that a high-explosive shell fired from it would have still less effect than if fired from the old gun. Hence the introduction of field howitzers. These howitzers are united in divisions of from 2 to 3 batteries and distributed in the ratio of one howitzer division per army corps.*

The tactics of heavy batteries have been studied also.† Separately from the light artillery, they will follow at the rear of the arms corps; far enough from the latter to avoid impeding the march, and near enough to enable the commander to call upon this artillery and make use of it at the favorable moment. It is thought that the conditions of modern war will make battles longer than formerly and that the heavy artillery will enter the line in time to do good service and even play a decisive rôle in "making a breach at the chosen point."‡

When the attack on a position is contemplated, the heavy artillery takes its place in the fighting column; the batteries are pushed further to the front, when the distance to be traversed is small, and when the ground affords an approach under cover.

The appearance of the new artillery in the line of battle will necessarily cause many modifications in present battle tactics. The artillery duels will attain an intensity never experienced before. The new pieces combine all the advantages of smokeless powders with the results of the great progress accomplished in the technical construction of cannon during the past twenty years. The *gun* again becomes "the principal force of armies."

(Translated by First Lieutenant ANDREW HERO, JR., 5th Artillery.)

* Von Loebell's *Jahresberichte*, 18—.

† General Speck of the Bavarian Artillery has sketched the logistics of heavy artillery on the offensive

‡ See *Journal U. S. Artillery*, Vol. X No. 2, page 160.

PROFESSIONAL NOTES.

ORGANIZATION.

Uraguay.

Our present Regular Army.—We give the following list of the forces which according to the last approved budget, constitute the regular army of the Republic:—

Infantry:	
1st, 2nd, 3rd and 4th infantry battalions, at 400 men each	1600
1 battalion "Urbano de la Capital"	300
Urban companies of Durazno, Salto, Artigas, Cerro-Largo, Trienta y Tres, Rocha, and Minas, at an average of 100 men each	700
Total bayonets	2600
Cavalry:	
1st, 2nd, 3rd, 4th and 5th regiments of cavalry, at an average of 300 sabres each	1500
Mobilized frontier regiment	300
President's escort, at 50 lances	50
Total cavalry	1850
Artillery:	
1 regiment of artillery	200
1 company "Fort General Artigas"	60
1 company "del Parque"	100
Total artillery	300
General Military Academy:	
Cadets	40
Troops	26
Total	66

—*Revista Militar y Naval*, November 15, 1898.

ARTILLERY MATERIAL.

a. Guns and Carriages.

*   *   *   *   *   *

b. Armor and Projectiles.

Test of a Bethlehem-Krupp Armor Plate.

At the Redington proving grounds of the Bethlehem Iron Company a very interesting series of tests were made recently on a 6¼-inch armor plate, face hardened by the Krupp process. The result is a particularly interesting one, in view of the fact that an 8-inch gun was used. The following is the official report:

Plate mounted on backing of 12 inches of oak and 1⅜ inches of soft steel skin plate and attacked by 8-inch navy rifle. Size of plate 108 × 74 × 6¼ inches.

First Round.—Fired October 8, 1898. An 8-inch French Holtzer armor piercing projectile; weight 250½ pounds; struck the plate with a velocity of 1520 foot seconds, developing an energy of 4017 foot tons; penetration ¾ inch;

point of impact 30 inches from top edge and 30½ inches from right hand end of plate. Projectile was completely broken and thrown to rear; plate and backing uninjured.

Second Round.—Fired November 2, 1898. Projectile, 8-inch Midvale Holtzer, 1898 manufacture; weight, 252½ pounds; striking velocity, 1623½ foot seconds; energy, 4619 foot tons; point of impact, 23 inches from right end, 26 inches from bottom edge of plate and 18½ inches from impact No. 1; penetration 2½ inches. Point of shot fused to plate and remainder broken and thrown to rear; no radial or other crack; slight spalling off of face of plate around shot hole; one backing bolt broken and wood of backing splintered at right end of plate.

Third Round.—Fired November 2, 1898. Projectile, 8-inch Midvale Holtzer, 1898 manufacture; weight, 252 pounds; striking velocity, 1730 foot seconds; energy, 5234 foot tons; point of impact, 27 inches from bottom of plate, 27 inches from impact No. 1 and 29 inches from impact No. 2; penetration, 6¼ inches. No cracks whatever; slight spalling off of face of plate around shot hole; head of projectile fused to plate and remainder broken and thrown to rear.

Fourth Round.—Fired November 3, 1898. Projectile, Midvale Holtzer, 1898 manufacture; weight, 252⅛ pounds; striking velocity, 1828 foot seconds; energy, 5847 foot tons; point of impact, 28 inches from top edge, 34 inches from left end and 26 inches from impact No. 3. Projectile passed through plate and backing, the broken pieces lodging in sand butt; no cracks in plate; slight spalling off of face of plate around shot hole.

Fifth Round.—Fired November 3, 1898. Projectile, Midvale Holtzer, 1898 manufacture; weight, 252 pounds; striking velocity, 1715 foot seconds; energy, 5144 foot tons: point of impact, 21 inches from top edge of plate, 26 inches from impact No. 4, 26 inches from impact No. 3 and 18 inches from impact No. 1; penetration, 5 inches. No cracks in plate; slight spalling off of face of plate; projectile broken and thrown to rear; plate and backing uninjured.

Sixth Round.—Fired November 4, 1898. Projectile, Midvale Holtzer, 1898 manufacture; weight, 252¼ pounds; striking velocity, 1821 foot seconds; energy, 5807 foot tons; point of impact, 24 inches from top edge, 17 inches from right end of plate and 14 inches from impact No. 1. Projectile penetrated and broken pieces lodged in plate and backing; the skin plate bulged but not cracked; slight spalling off of face of plate around shot hole; no cracks in plate, although this shot was very close to the corner of the plate and to impact No. 1, and the backing supporting this portion of the plate had been badly splintered by previous shots.

Round.	Gun. Inch.	Velocity. Foot seconds.	Weight of shot.	Energy. Foot tons.	Penetration of actual plate. inch.	Factor above DeMarre formula.
1 . . .	8	1520	250½	4017	¾	1.37
2 . . .	8	1623½	252½	4619	2½	1.47
3 . . .	8	1730	252	5234	6¼	1.56
4 . . .	8	1828	252⅛	5847	Perforated	1.65
5 . . .	8	1715	252	5144	5	1.55
6 . . .	8	1821	252¼	5807	Projectile broken up and lodged in backing. Skin plate bulged but not open.	
Total energy				3[illegible]		

Last column of table gives the factor obtained by dividing the actual velocity by velocity calculated by DeMarre formula for perforating steel plate of equal thickness.

—*Iron Age*, November 24, 1898.

With the other successful results of Krupp process plates comes a remarkable one from Bethlehem. The figures in the table below speak for themselves. The photograph of the front of the plate bears them out so far as it goes. It may be seen that six 8-inch shot were delivered on points within an

area of 4 feet by 2 feet, that a rectangle 6 feet by 4 feet nearly covers the entire damaged portion of the plate. Under these circumstances the absence of cracking is very striking. Last week, in recording the success achieved by the Beardmore plate, we observed that the toughness of Krupp process plates could not be claimed for it, whatever its other advantages might be. We were sorry to make any such qualifying remark, but justice seemed to demand it. This result, we think, bears this out. We have to admit that the principal witness as to toughness—that is, the photograph of the back of the plate—is wanting. This we greatly regret. Nevertheless, we have evidence sufficient to bear out the conclusion that the remarkable toughness which we attributed to the Krupp process plates, on our first receiving the results of the 1895 trials, is here present. For we have a plate 6¼ inches thick attacked by six 8-inch projectiles. The width of the plate is 6 feet 2 inches, so that when it enters deep the shot acts as a wedge nearly one-ninth the width of the plate. The striking energy of the heaviest blow which perforated was 5842 foot-tons, or about 880.2 foot-tons per ton of plate, supposing the plate to have weighed, as we calculate, about 6 tons 12½ hundred weight. The heaviest blow which did not produce perforation, but whose shock was resisted, was 5229 foot-tons, or 789.6 tons per ton of plate. The absence of cracks under these conditions is to be noted. Much as we regret the absence of the view of the back as bearing on this, we also regret it because it would have been most instructive in showing how the plate yielded under the strain of complete perforation and approach to perforation in various degrees, and in what measure boring was defeated and punching made to take its place. With regard to perforation, Round No. 3, when the shot's point reached to a depth equal to the thickness of the plate - that is 6¼ inches—and No. 6, when the projectile got through, but broken pieces remained in the backing and plate, fix the maximum resistance or figure of merit as something between 2.46 and 2.50. That is to say, this is the relation of the thickness of wrought iron that the shot is calculated to perforate by Tressider's formula to the actual thickness of this plate. Lieutenant Meigs who has kindly furnished us with these results, gives it in the form of the relation of steel, which by DeMarre's formula would be perforated to the actual plate's thickness, a ratio which he makes 1.56 and 1.65 for rounds 3 and 6 respectively. We dislike this system because we regard steel as such a variable substance that in spite of DeMarre's preference for it—a preference which we must own has been also expressed by Vickers—we question if a practical standard can be thus furnished. If practical investigations were to be undertaken to-morrow, could any one make sure that they had this, or rather, either of these qualities of steel, for we doubt their being the same? On the other hand, although wrought iron may be a rough standard, any one in any armor-plate manufacturing district in the world could obtain it.

We naturally ask, finally, is there anything to qualify the weight of the results here given? It is to be noticed that the trial took place not at Indian Head, the Government proving ground, but at Redington, which is, we suppose, the proving ground belonging to Bethlehem. Hence we are justified in assuming this to be not only a champion plate, but probably the selected result of all champions. Bethlehem, however, may very well be content to allow this in taking their stand on such a result. With regard to the shot, our constant difficulty comes up. Holtzer are very good if fairly taken. The Holtzer 6-inch shot that we always feel called upon to discount are those delivered before 1889, and repudiated by Holtzer as made before the introduction of hard-

faced plates. At the same time, having seen some indifferent Holtzer 8-inch shot used in America, we should be glad to have some definite information as to these; and we can only again repeat our wish that we could get some standard shot adopted, and one sample fired in every plate trial. The data of the trials are as follows :—

Result of Bethlehem-Krupp Process Plate attacked at Redington in October and November, 1898.

Number of round.	Date, 1898.	Shot, 8-inch	Weight of shot, lb.	Striking velocity, foot-seconds.	Penetration, inches.	Perforation of iron by Tresidder, inches.	Relation of calculated perforation to thickness of plate.	Striking energy, foot-tons.	Striking energy per ton of plate, foot-tons.
1	Oct. 8th	Holtzer . .	250½	1520	¾	12.6	2.02	4013	604.5
2	Nov. 2nd	" Midvale	252½	1624	2½	13.9	2.22	4618	695.8
3	"	" "	252	1730	6¼	15.4	2.46	5229	789.6
4	Nov. 3rd	" "	252⅛	1828	through	16.7	2.67	5842	880.2
5	"	" "	252	1715	5	15.1	2.42	5139	774.1
6	Nov. 4th	" "	252¼	1821	*	16.0	2.56	5799	873.

* Through, pieces lodged in plate and backing.

The plate measured 9 feet by 6 feet 2 inches by 6¾ inches.

—*The Engineer*, December 2, 1898.

Krupp Armor—Its Application to Defeat Shell Fire in Warships.

During the last few months news has come to us of marked success, in both America and England, with thick Krupp armor. In England Brown and Cammells are the makers, in America the Carnegie Company. We are giving full data as to these trials, with official photographs of the plates, as we obtain them. For the moment we are only considering the results broadly. Of Brown's plate trial we have given an account.

Of Cammell's plate we have also now received a full account. It was attacked by three Holtzer armor-piercing projectiles, each nearly 720 pounds weight, striking with about 1860 foot-seconds velocity. These shots were completely broken up with less than 4 inches penetration, and cracking was limited to one thin line running from the third point of impact to the upper edge of the plate. The Carnegie plate was 12 inches thick and it was attacked by three 12-inch armor piercing projectiles, each weighing 850 pounds. The first had 1833 foot-seconds striking velocity, and is said to have penetrated 8½ inches, and remained embedded without producing cracks. The second struck with 2022 foot-seconds velocity, and passed clean through into the backing breaking up badly. The third round, striking with 1720 foot-seconds, only penetrated 5 inches. It would need closer examination than we can now give to deal effectually with the behavior of these two plates. The calculated perforation of each blow on Cammell's is about 23.8 inches of iron, that is, rather over 2.0 times the thickness of the actual plate. This only achieved a penetration of less than 4 inches. The first blow on Carnegie's had a calculated perforation of 25.0 inches of iron, or not quite 2.1 times the thickness of the

plate attacked. This achieved a penetration of 8½ inches. The second perforated with 29.0 inches calculated perforation of iron, that is 2.41 times the plate's thickness. The third, with 22.6 inches calculated perforation, or 1.88 times the plate's thickness, entered to a depth of 5 inches. Apparently the Cammell plate broke up the shot rather better than the Carnegie, but as we do not know the relative powers of the shot it is impossible to make a fair comparison. This trial may be said to assure the adoption of Krupp process plates in the United States for thick as well as thin armor.

We believe that makers will concur with us in saying that all Krupp process armor is difficult to make, at all events at first, and that thick plates are beset with obstacles such as are enough to defeat any efforts, except those made with skill and great perseverance. We may point in support of this to the fact that, during the two years that Krupp armor has been under trial in this country, the successful trials of thick plates, so far as we kuow, could be almost counted on the fingers of one hand. Once success is attained, however, we imagine that the process has been so carefully watched in all its phases and surroundings, that it can be reproduced very much more easily and certainly, so that we may now hope that Sheffield could shortly turn out thick Krupp process plates as a matter of supply on a large scale.

It may here be noticed that the toughness of Krupp plates seems to us to offer peculiar advantages. A hard face defeats the boring attack of a sharp-pointed projectile by fracture of point; but it is open to question whether it makes much difference to the punching attack of common shell. Such attack, of course, is only successful when the plate is weak in comparison to the projectile or attacking gun. This form of attack, however, is important in the lighter parts of a ship, and when lighter plates are used in virtue of their having hardened faces, it may be found that such plates are more open to the punching attack of common shell than the alternative thicker plates, which were inferior in their resistances to the boring attack of sharp-pointed armor-piercing shot. It follows, then, that the great toughness certainly possessed by Krupp process plates may supply the increased resistance to common shell attack that should, if possible, go hand in hand with that of armor-piercing shot, if we are to obtain the full benefit of better armor.

The broad fact that chiefly concerns us, from a gunnery point of view, is that 12-inch Krupp plates have defeated 12-inch projectiles under such conditions that it is obviously very improbable that this armor could be perforated in action. It follows surely that nothing thicker than 12-inch Krupp armor is likely to be employed in future designs; consequently, the saving in weight is likely to be utilized in other ways. Sir William White, indeed, has long since reduced our side armor on the faith of results obtained with Harveyed plates to 9 inches, supported, however, by the inclined steel deck as a second defence. So far as the vital parts below the horizontal armor are concerned, this ought to be abundant; though incidentally we may repeat that we wish that a target representing an actual ship's section could be fired at, to see what destruction is effected in the upper structure.

The introduction of Krupp process armor, coming as it does, with the evidence from the Santiago fight as to the complete manner in which a ship is disabled by fire delivered on her upper structure, will, we think, surely cause a considerable extension of armor in the secondary parts, coupled with the disuse of wood. In one way, then, we are going round the circle again. The *Warrior* and early ships were nearly covered with armor, which was at that time able to defeat all gun-fire. Then, as gun-fire increased in power, the

attempt to protect all parts was given up, and the so called vital parts were covered with plates of greatly increased thickness, the secondary parts taking their chance. Quick-fire then came in, delivering such a hail of mitraille that thin plate was gradually brought in at all costs; the ship's displacement increasing helped to make this possible.

The shell fire has now become more formidable than ever, but happily armor has been so wonderfully improved as to be able to assume more and more functions of defense. Armored decks were the natural complement of the vertical defense limited to vital parts, but traverses, casemates, and the like grew up gradually, so that it may be urged that thin armor has returned in a more scientific form than in old days. This is true, but the broad fact remains that owing to the increased volume of quick-fire, with increased explosive and incendiary power, coupled, on the other hand, with the growing hardness and toughness of armor, our ships are becoming much more completely sheathed in plates, and the armor is much thinner, while the guns have gone back from the few heavy pieces of the *Thunderer* and *Inflexible* to an armament corresponding in numbers much more nearly to those of the old *Warrior* and *Agincourt*.

The alterations that appear to be likely, then, are as follows:— The thick narrow complete belt will disappear. The Spanish ships at Santiago had 12-inch belts which may be called complete, although they tapered to a point at bow and stern. They represented considerable money and weight, yet it may be questioned if they were any use at all. A ship which can be so quickly destroyed by fire on her upper structure would even have fared better without any belt, which only weighed her down. The proper solution, however, is not to do away with the latter, but to substitute much thinner plates. For a cruiser, which presumably will not be called upon to fight in line with men-of-war, the plates should be specially hard, so as to afford the maximum resistance to a single blow, rather than power to bear long continued attack. The armor thus saved in the belt will no doubt be employed to protect the quick-firing batteries and other important parts of the upper structure. The *Christobal Colon*, although her belt was continuous, nearly embodied what is suggested. She had a belt 6 inches thick, from which 6-inch plating was carried upward amidships, so as to cover the quick-firing guns and the whole space between the principal heavy guns, and as a result the *Colon* is said to have suffered but little, and surrendered, not because of injuries received, but rather owing to the hopelessness of engaging the *Brooklyn* and *Oregon* together, when it became clear that they had both practically come up with her. Evidently the horrible incendiary effect caused by common shell must be prevented as far as possible. The Germans have got rid of all wood; we take it that it will only be a question of time before we do the same. It seems curious that the instant action of explosion should fire solid wood as it does. Probably, lumps of burning powder are driven into the wood, and these carrying their own oxygen in the composition burn so fiercely that even water might fail to put them out. It is easy, however, to conceive that a structure covered with thin hard plates, and with no wood, would bear the fire of common shell sufficiently well to show that belt attack might become, what it never did at Santiago, a matter of great importance. Certainly, with battleships this would be the case. Consequently, we do not anticipate that the heavy principal guns will be entirely replaced by quick-firers. We give herewith a copy of the official table of the hits made on the Spanish ships, by which it appears that the 12-inch guns made a larger num-

ber of hits, in proportion to their number, than the 6-inch. We lay no great stress on this table, however, the number of rounds being too small and the conditions to uncertain to give any trustworthy average. Taking the whole question as it stands, however, we anticipate that a modified thickness of belt, a great extension of thin armor, and the abolition of wood, will be the chief alterations to be looked for in the immediate future, changes, which can hardly be said to have been first suggested, but rather to have been rendered obvious by the engagement at Santiago, and which are rendered much more feasible than they would have been a few years since by the introduction of hard faced armor, especially by such as, in the case of Krupp process plate, combines with hardness great toughness.

Official Table of Hits made on the Spanish Cruisers at Santiago showing the Number of United States Guns Firing at them.

(*From the Scientific American.*)

Nature of U. S. projectiles.	Number of hits on Spanish ships. Teresa.	Oquendo.	Viscaya.	Colon.	Total.	No. of U. S. guns.	Hits per gun.
6-pounder	17	43	13	4	77	42	1.83
1-inch	2	—	—	—	2	13	0.15
4-inch	1	7	4	—	12	3	4.0
5-inch	3	3	7	2	15	6	2.5
6-inch	1	1	—	1	3	7	0.43
8-inch	3	3	5	1	12	18	0.67
12-inch	2	—	—	—	2	6	0.33
13-inch	—	—	—	—	—	8	0.00
	29	57	29	8	123		

—*The Engineer*, November 4, 1898.

c. Powder and Explosives.

High Explosives in Naval Warfare.

Their composition, uses, and present value.

Although the substances that have been proposed for use as explosives number many hundred, yet most of them possess no practical value, and owing to the conditions which they must satisfy, only very few can ever be used in warfare, except as emergency explosives. The explosives which are employed belong to one of four classes,—gunpowders, organic nitrates, nitro substitution compounds, and fulminates.

Gunpowder consists of potassium nitrate, charcoal and sulphur, intimately mixed by grinding the powdered materials, when moistened with water, under heavy stone or iron wheels and pressing the material thus obtained into the desired form of grain. The gunpowder which has for a long time been in use, and which during the late Spanish-American war was issued for use with the American Springfield rifle, consists of seventy-five parts of potassium nitrate, fifteen parts of black charcoal, and ten parts of sulphur, which, after mixing on the wheel mill, is pressed into cakes. These cakes are then broken into coarse particles in a breaking-down machine, and the angular, irregular grains are sorted out by passing the broken mass over graduated sieves.

The more modern gunpowder, known as cocoa or brown prismatic powder, contains under-burned or brown charcoal, so that some of the carbohydrates remain, and the proportions of the ingredients are also different, the German cocoa being compounded of 68 parts of potassium nitrate. 20 parts of charcoal, and 3 parts of sulphur. The mixture is compressed in a powerful

hydraulic press into separate grains, which have the form of an hexagonal prism, and which are perforated through their longer axis by a hole or canal.

The brown prismatic grains for the United States Navy guns measure 1.26 inch in diameter, 1.05 inch in height, with a hole of 0.32 inch in diameter for large grains, and 0.94 inch diameter, 0.87 inch in height, and 0.17 inch diameter of canal for the smaller grains. The advantage which this brown gunpowder possesses over the black is that as it is slower burning it is less *brisante*, and that, therefore, a higher velocity may be imparted to the projectile without bringing an undue pressure upon the walls of the gun.

It is, however, not only slow-burning, but also difficult of ignition, and it is, therefore, necessary to press grains of similar form and dimensions from the quicker burning and more easily ignited black powder, and to place a number ot these ignition grains in the base of the cartridge which is to be placed in contact with the primer in the breech-block of the gun.

An absurd situation grew out of this necessary adjustment at an official exhibition given at Fort Washington, on the Potomac, a few months ago. A deputation from the United States Congress was invited to witness the behaviour of a disappearing gun that had recently been mounted at that important point of defence. The first round was fired, to the amazement of some and the satisfaction of all. On the second round the magnificent weapon was elevated and the order to fire given, but without effect, and after investigation it was ascertained that the failure was due to the cartridge bag having been reversed in loading the piece.

Explosion of a mine charged with joveite.

(By courtesy of the Cassier Magazine Co.)

The properties of gunpowder are so well known that it is unnecessary to dwell upon t em. Although there is some question as to the permanency of brown prismatic powder, yet on the whole its reliability constitutes its chief advantage. A marked disadvantage, and one which recent events have strongly impressed upon the public, is the smoke which it produces when fired, more than fifty per cent. of the total weight of the powder charge being thrown out as solid matter to foul the atmosphere, becloud the gunner, and make his situation a conspicuous target for the enemy.

Many smokeless powders are now known and used, and all the principal ones belong to the second class of explosives mentioned above, as they are composed wholly, or in part, of organic nitrates. The most typical members of this class of explosives are gun-cotton, which was discovered by Schönbein, in 1845, and nitro-glycerine, which was discovered by Sobrero in 1847. Gun-

cotton is made by immersing cold, thoroughly dried and thoroughly cleansed cotton fibre in a mixture of nitric and sulphuric acids, when nitrogen oxides from the nitric acid replace part of the atoms of hydrogen in the molecules of the cotton, or cellulose, as it is called by the chemists.

If the acids are the strongest that are made and the temperature during nitration is kept low, and the immersion lasts for several hours, the greatest degree of replacement of hydrogen atoms by nitrogen oxide groups takes place; but if the temperature rises or the acid mixture is weak and the time of immersion is short, fewer of the hydrogen atoms of the cellulose molecule are replaced, and by taking advantage of these conditions we obtain cellulose nitrates containing from four to eleven atoms of nitrogen in the molecule, and each of these nitrates possesses different properties, but all of them have, by

Shaping charges of gun-cotton with a band saw.
(By courtesy of the Cassier Magazine Co.)

this treatment, become to a degree explosive, their explosibility increasing with the increase in their nitrogen contents.

It may appear singular that further contact with acid, and especially sulphuric acid, will cause the decomposition of these cellulose nitrates; yet such is the case, and therefore it is necessary, after nitration, to free the cellulose nitrates rapidly and completely from the acids present, which is done by wringing out the mass in a centrifugal machine and immersing the mass in a tank containing a large volume of rapidly changing water, in which the cellulose nitrate is kept in agitation by a revolving feathered wheel; afterwards

it is boiled with water which usually contains a small quantity of sodium carbonate.

As, however, the cotton fibre is in the form of capillary tubes of considerable length, this washing and boiling does not suffice to remove the acid from the interior of the tubes; the material is, therefore, put into a pulper, or rag engine, such as is used in paper-making, and pulped to the fineness of corn-meal, while at the same time it is washed by a continuous change of water until by chemical tests it is found to be free from acids.

None of the cellulose nitrates before pulping and when dry present any different appearance to the eye from the cotton from which they were made, but they have a harsher feel. They all burn much more readily when ignited, and the higher-nitration ones especially flash off instantly without producing any smoke or leaving any appreciable residue. Unlike cellulose, the cellulose nitrates of lower nitration are soluble in a mixture of ether and alcohol, while the higher ones are not, but are soluble in acetone. The nitrates soluble in ether-alcohol are known as pyroxylin, or collodion gun-cotton, and are used in the manufacture of celluloid, collodion and like substances, while the nitrates of the highest nitration are more specifically known as gun-cotton or military gun-cotton.

It is this latter which has been used for filling torpedoes, mines and shell, and for the purposes of demolitions. To prepare it for use, the pulp from the rag-engine is conveyed to a moulding press and the moulded disks or blocks are taken to a final hydraulic press, where they are fashioned into the desired forms, just as *papier maché* is. As taken from the press these blocks contain from twelve to sixteen per cent. of water, but as sent into the service they contain about thirty-five per cent., which is added by allowing the compressed blocks to soak in a trough of fresh water until they cease to absorb more. If, in providing charges for torpedoes and shells, it is inconvenient to mould the portions for the ogival shaped heads or other parts, these are readily and without much danger shaped from blocks on hand by cutting them with a chisel or hand saw, or boring with a drill, or turning in a lathe, being careful to keep a stream of water flowing on the gun-cotton during the operations.

When thoroughly dry, compressed gun-cotton may be set on fire, and it burns with considerable vigor; but the writer has repeatedly set on fire blocks weighing several ounces, and when they were well ignited extinguished them by pouring water upon them. Dry gun-cotton does not explode when ignited, except when confined.

Wet compressed gun-cotton does not take fire until dried. The writer has frequently placed stout boxes of it, containing upwards of 100 pounds, in a fierce bonfire and allowed the boxes to burn through, when the disks slowly dried in layers and ignited on the outside, but would be extinguished by simply rolling them out on the earth. Nor is wet gun-cotton exploded by the impact of a projectile.

Wet gun-cotton is, however, exploded by the detonation of a small amount of dry gun-cotton in contact with it, and the detonation of dry gun-cotton is effected by means of a detonator, or blasting cap, containing mercuric fulminate, fired in contact with it. The explosion produced in this way is an extremely violent one, it has a marked rupturing effect, and can be effected without confinement of the explosive. It is sufficient to place the thoroughly saturated gun-cotton upon the ground, to put on this a small block of dry gun-cotton containing a detonator inserted in a hole in the block, and to fire the

detonator by a fuse or an electric current, when the whole of the gun-cotton will be instantly exploded and resolved into gas.

The second typical explosive of this class, nitro-glycerine, is made by slowly mixing pure glycerine with strong nitric and sulphuric acids, being careful to keep the temperature down while the nitration goes on. Here also nitrogen oxide replaces hydrogen in the glycerine molecule, and we obtain, after washing, a liquid which looks like the bland, innocuous glycerine with which we are so familiar (though the commercial nitro-glycerine is usually yellow), but which is poisonous and explosive.

Theoretically, there are three glyceryl nitrates, but the nitro-glycerine with which we are practically acquainted is the glyceryl tri-nitrate. The washing of the nitro-glycerine is more easily accomplished than that of the gun-cotton, yet, perhaps, on account of foreign bodies present, its stability is not so well assured. When set on fire nitro-glycerine burns vigorously : if spread out on a surface, it may burn away without explosion, but if the surface with which it is in contact becomes heated, the nitro-glycerine will explode with violence. It is usually exploded by means of a detonator or blasting cap, and it is then instantly resolved into gas. It can be detonated unconfined, but its efficiency, in common with all other explosives, is increased by confinement. As it explodes in direct contact with water, the latter is often used to confine or tamp it, as it is called, when used in blasting.

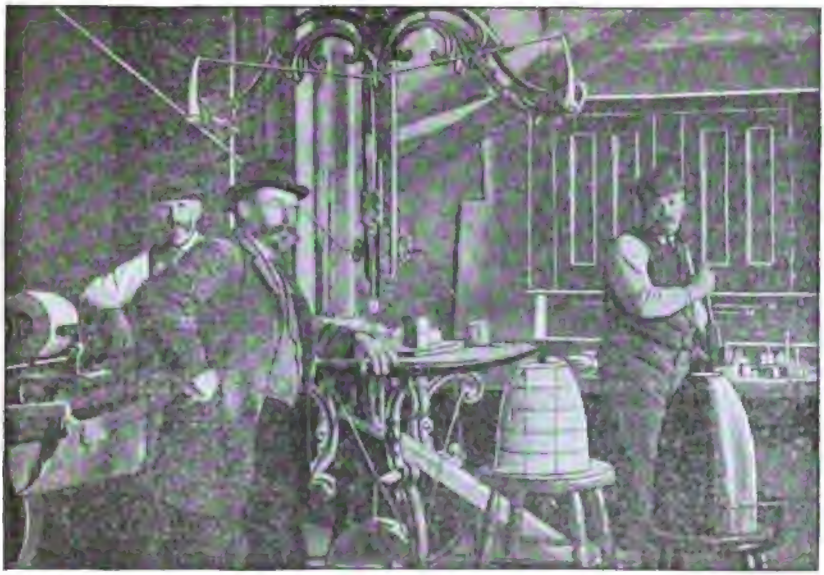
Nitro-glycerine poisons when it is taken into into the mouth, or absorbed through the skin, or inhaled, as vapor, and even very small quantities produce violent headaches. It is readily exploded by a blow. It freezes at from 39° to 40° F., and remains in this condition even when exposed to a much higher temperature for some time. When frozen it is exploded only with great difficulty.

Because of the danger attending the liquid state and the great sensitiveness of nitro-glycerine it is converted into a component of a solid mass by absorbing it in a porous material, like infusorial silica, when it is known as kieselguhr dynamite; or a mixture of wood pulp and sodium nitrate, when it is known as lignin-dynamite; or by dissolving pyroxylin in it by the aid of heat, when it is converted into a jelly-like mass, known as explosive, or blasting gelatine. The latter may be further mixed with cotton or charcoal, when it is known as gelatine dynamite. All these owe their explosive properties to the nitro-glycerine, and the gelatines to the pyroxylin also, contained in them, and they exhibit many of the good and bad qualities of the nitro-glycerine. The explosive gelatine is the most powerful and least sensitive of these nitro-glycerine substances. All, in common with gun-cotton, have been known to undergo dangerous spontaneous decomposition.

Although much longer known and used than the organic nitrates, none of the nitro-substitution compounds have ever been known to undergo spontaneous decomposition, and they offer a greater assurance against the user being "hoist with his own petard" than any of the explosives known. Picric acid, or trinitrophenol, the first member of this class, was discovered by Hausmann, in 1788, but the number of the nitro-substitution compounds now produced is very great. Among them may be mentioned the nitro-benzenes, nitro-toluenes, nitro-phenols, nitro-cresols and nitro-naphthalenes, all being produced by the action of nitric and sulphuric acids an substances, such as benzine and carbolic acid, produced in the distillation of coal. None of these bodies explode by simple ignition unless strongly confined, and they are extremely insensitive to shocks or blows; but Berthelot has shown that if a

mass is uniformly heated to a certain temperature, which, fortunately, is far above any natural temperature, and which is constant for each body, the substance will explode with great violence.

These substances are sometimes used alone as explosives, either in the fused or granulated state, and we have examples of this in melinite and lyddite, which consist of fused picric acid. More frequently they are mixed with oxidising agents, as in ecrastic, which consists of ammonium trinitrocresylate and potassium nitrate; in emmensite, which consists of picric acid, dinitro-benzene and ammonium nitrate; and in joveite, which consists of nitro-phenols, nitro-naphthalenes and sodium nitrate. These explosives are made by melting the nitro-substitution compounds in steam-heated kettles, and then mixing in the finely powdered oxidising agent. They are so insensitive as to require powerful fuses, but they are detonated by strong detonators or gun-cotton primers.



Chiseling and turning blocks of gun-cotton for charging shells. The brass nose of a shell is shown on the right-hand stool, and the charge for this on the left-hand stool and in the lathe.

(By courtesy of the Cassier Magazine Co.)

As noted, all of these explosives require an initial charge of mercuric fulminate with which to to detonate them. This body, which was the first, and is still the best known, of the fulminates, was discovered by Howard, in 1800. It is made by dissolving mercury in nitric acid and pouring the mercuric nitrate thus formed into ordinary alcohol. A violent reaction soon begins, dense clouds of white and then orange colored vapors are evolved, and then the mercuric fulminate is precipitated out in small, gray, beautifully formed crystals which are washed with water and stored wet.

This body is exceedingly dangerous. It is very sensitive and explodes with great violence. When dry it is exploded by heat, percussion, concussion, friction, flame or spark. Wet fulminate is exploded even when immersed in

water by the explosion of dry fulminate in contact with it. Mercuric fulminate always undergoes a detonating explosion, and, according to Berthelot, it will develop, in contact, the enormous pressure of 360 tons per square inch, and this is developed instantly.

Mercuric fulminate is used in loading primers, caps and detonators. The United States Navy detonator consists of a copper case, 1⅛ inch long by 11-32 inch in diameter, in which are placed 35 grains of dry mercuric fulminate. On the mouth is screwed a copper cap, ⅝ inch long and 12-32 inch in diameter, fitted with a plug made of sulphur and glass. Two copper wires are fused in the plug, the inner ends being connected by a fine wire, composed of platinum and iridium, to form an electric bridge, and the outer ends being left free to connect with a battery or dynamo-electric machine when it is desired to fire it.

As the cap is screwed on the case, the space between is filled with mealed gun-cotton, and, after closing, the whole case is painted with a composition to make it water-tight. Although in the writer's experiments he found that steam-dried gun-cotton can be detonated by three grains of mercuric fulminate, and air-dried gun-cotton by five grains, provided the fulminate is well confined in thin copper cases and the cases are in intimate contact with the gun-cotton, yet thirty-five grains are employed in the service detonator to afford a large ceofficient of assurance.

It is well known that if a pile of unconfined gunpowder of considerable size be ignited, it will flash off without doing any material damage to the support on which it rests, although that support may be very frail; but if even a few ounces of gun-cotton, or nitro-glycerine and the dynamite made from it, or mercuric fulminate, be placed unconfined upon even a stout support, such as a rock or a piece of steel, and detonated, the rock will be shattered or the steel will be indented.

This difference in effect is explained by the fact that as gun-powder is a mixture of bodies which react upon one another, the chemical change goes on with comparative slowness and the gases evolved are gradually dissipated, while as the other bodies enumerated are chemical compounds which contain all the elements necessary to combustion, the change is one of molecular disintegration, and it takes place so quickly that the resulting gaseous molecules impinge with an enormous velocity upon the supporting body before they escape into the atmosphere. Owing, then, to this difference in the speed of the chemical reaction taking place, the explosives of the gunpowder class are styled low explosives, while the others, just enumerated, are styled high explosives. The low explosives are used as propellents, and in blasting when it is desired to avoid shattering effects, while the high explosives are employed when a violent shattering of the object attacked is sought.

Nevertheless, we can, by suitable treatment, so change the physical characteristics of gun-cotton and nitro-glycerine that they may be used as propellents, and they, thus, become low explosives. The change consists in simply converting them by the aid of solvents and pressure into dense solids, like hard glue or ivory, and in this way are formed the modern smokeless powders. Thus the powder with which the United States Navy is now experimenting is practically celluloid, which is made by heating pyroxylin with ether-alcohol until a plastic mass is formed, which is then squirted by powerful hydraulic presses into strips of different dimensions. These are dried to remove the solvent.

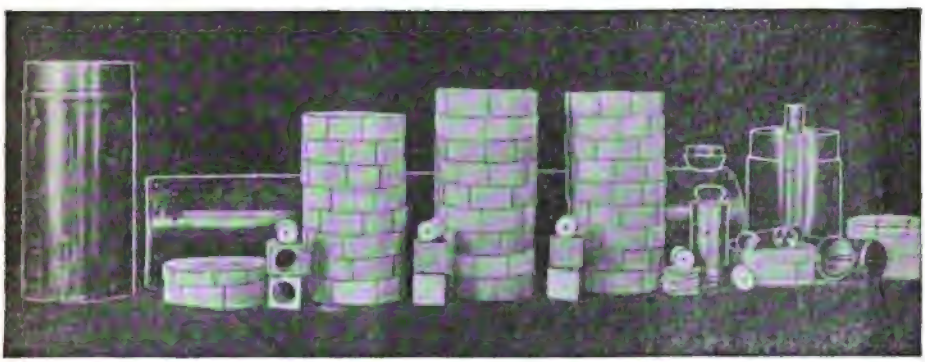
The American naval smokeless powder of 1892 consisted solely of gun-cotton of the highest nitration, and was made by treating military gun-cotton with

methyl alcohol to remove any pyroxylin, and then with mono-nitro benzene by which a plastic mass was produced, which was squirted into rods, or rolled into sheets and cut into grains. These were treated with boiling water to remove the nitro-benzene, when the gun-cotton was found to have the hardness and lustre of ivory.

This was the first powder ever produced that consisted of a single chemical substance in a state of purity, and it gave low pressures and imparted high velocities to the projectile, while its permanency is assured by the fact that samples which were exposed for months to toasting in a steam closet and freezing in an underground magazine remain to-day unchanged.

The cordite used in the British Navy consists of a mixture of pyroxylin and gun-cotton with nitro-glycerine, while the ballistite of Germany and the filite of Italy consist of pyroxylin and nitro-glycerine. These are but a few of the mixtures of cellulose nitrates and nitro-glycerine proposed for use, many of them having also oxidising agents, nitro-substitution compounds, and other bodies as constituents.

The use of the high, or rupturing, explosives for naval purposes is confined to the blowing-up of obstructions, such as booms and chains, to the filling of



Cylindrical charges of gun-cotton which have been sawn from service blocks.
(By courtesy of the Cassier Magazine Co.)

mines and torpedoes, and to the loading of shells. Gunpowder has been used with effect for all these purposes, but the greater power and speed of reaction of the high explosives render them more efficient, and they are employed wherever this can be done without unnecessary danger to the user.

Although explosive gelatine, as fired in mines, is about 5.6 times as efficient as the same weight of gunpowder, it, in common with other nitro-glycerine explosives, has exploded when stored in magazines, while besides, it can be exploded by shock and impact, and thus it is unsuitable to be stored on board ship or to be fired in shells. The less powerful, but less sensitive, gun-cotton and nitro-substitution compounds, and more particularly the latter, are free from these objections, and wet gun-cotton is now altogether used for naval mines and torpedoes, a small priming charge of dry gun-cotton and a fulminate detonator being used with which to fire the wet charge, and these elements are carefully stored in widely separated places until the missile is wanted for use, while the amount of dry gun-cotton on hand is always kept at a minimum and frequently rigorously tested.

The limited range of even the best of torpedoes; the fact that torpedo-boats

can never expect to reach the enemy except by stealth; that this difficulty is continually increasing with the increase in the speed of battle-ships and cruisers, the perfection of search lights, and of rapid-fire, high-powered guns; and that, in any event, a torpedo attack is in the nature of a forlorn hope, makes it inevitable that some more efficient method of reaching the enemy with high explosives must be employed, and this is to be found only in gun fire.

Two systems of gun fire have been proposed and tested. In one of these a low-pressure gun of long bore is used, and the propellent is a slowly expanding, compressed gas, as is the case with the pneumatic guns on the United States dynamite cruiser *Vesuvius*. In the other, the regular service gun, service powder and service pressures and velocities are used to project the explosive-charged shell. Evidently, as the projectile from the pneumatic gun has a much more limited range and a lower velocity than the projectile from the gunpowder gun, the latter system is the more effective, and especially as its projectile has great power of penetration, which is an essential condition of efficiency.

It is true that large charges of high explosives may be thrown with pneumatic guns while the charges from gunpowder guns of the most-used calibres will be comparatively small; but the effect produced by the latter after penetration within a ship or the walls of a fort, or even in earth, is vastly superior to the superficial explosion of the former and larger charges. How great this difference is may be more fully realized by considering the results attained in actual experience.

Among the many accidents which are on record, one of the most notable is that of the explosion of 55 tons of blasting gelatine which was being unloaded from a railway train at Braamfontein, 300 yards west of Johannesburg, in South Africa, on February 19, 1896, and which was exploded by an end-on collision. The result of the explosion of this enormous quantity of one of the most powerful explosives used was to produce a crater 300 feet long, 65 feet wide, and 30 feet deep in soft ground; or, taking a cubic foot of earth as weighing 100 pounds, the superficial explosion of this 55 tons of explosive gelatine excavated about 30,000 tons of soft earth.

Besides this, there was a total destruction of all buildings within a radius of 330 yards, while from that distance to 660 yards all the buildings were shattered, and the roofs were battered in up to about 1,000 yards; but these buildings were built chiefly of corrugated iron and mud, and therefore were of a most unsubstantial character.

On the other hand, we have the blowing up of the Hudson river Palisades at Fort Lee, in 1893, when the explosion of 2 tons of dynamite, placed in a chamber in the rock, brought down 100,000 tons of rock; the blasting at the Dinorwic Quarries, Lamberis, in the same year, when 2½ tons of gelatine-dynamite, placed in chambers in the dyke, overthrew 180,000 tons of rock; and the destruction of the famous Talcen Mawr, in 1895, when 7 tons of powder, poured into two shafts, dislodged a mass of rock computed to weigh from 125,000 to 200,000 tons.

From this we find that the dynamite on the interior at Fort Lee was over ninety times as efficient as the explosive gelatine on the surface at Johannesburg, while the powder at Talcen Mawr was over forty-two times as efficient. It is, hence, not surprising that the superficial explosion of the 300-pound charges of gun-cotton thrown by the *Vesuvius'* guns at Santiago during the late war between the United States and Spain, produced no serious structural

damage, and simply harassed the enemy by their frightful reports, which occurred at infrequent intervals and unexpected times.

Even this would have a military value, but for the fact that gun-cotton and nitro-substitution explosives can be, and repeatedly have been, used as shell charges for service guns. When gun-cotton is so used, the material is not only well wet with water to render it insensitive, but it is cut into small masses, which are coated with a water-proof composition, and then these pieces are packed in the shell, surrounded by a mixture of paraffine and carnuba wax, which is poured in hot and allowed to congeal. The mass is exploded by a dry gun-cotton primer and fulminate detonator. Many shells so loaded have been successfully fired with good effect; but, unfortunately, no one seems informed as to how they will behave after they have been stored in the tropics and in cold climates and the charge has become broken up by the expansion of the inclosed water, as would inevitably be the case.

Fortunately, the nitro-substitution explosives are free from liability to change through changes of temperature, for when manufactured they are heated to temperatures far above any occurring in nature, and, as used, they are anhydrous solids, and therefore unaffected by freezing temperatures. The shells are filled by warming the material in a steam jacketed kettle until the explosive becomes plastic and then ramming it into the shell, where it sets to a rigid solid, which does not "set back" when the projectile starts, as gunpowder does, nor does it rotate in the shell as the latter takes the rifling. Many shells so loaded have been successfully fired, and, in fact, it is said that France has many shells loaded with melinite stored in her magazines, while Great Britain has issued shells filled with lyddite to the Channel Squadron, and the United States Naval Bureau of Ordnance has for several years past been conducting experiments with joveite at Indian Head, Md.

Having proved, by firing common shell, loaded with the various explosives in wooden chambers, that the destructive effect of joveite was greater than that of gunpowder, smokeless powder, or gun-cotton, the United States officials proceeded to fire joveite-filled shells from service guns until on November 3, 1897, a ten-inch Carpenter armour-piercing shell containing 8.25 pounds of joveite was fired with a velocity of 1860 foot-seconds at a Harveyised nickel-steel plate 14.5 inches thick, when the shell passed completely through the plate and burst on the farther side. Only a gunpowder fuse was used, thus eliminating all the danger to which a detonating fuse gives rise.

In a second round on the same day, a 10-inch Midvale semi-armour piercing shell, containing 28 pounds of joveite, was fired with a velocity of 1925 foot-seconds at a point on the armour for the new United States battle-ship *Kentucky* where it was 16 inches thick. The shell contained no fuse whatever, but it penetrated the plate to a depth of 12 inches and exploded by impact. The plate was broken through at previous cracks and but one piece of the shell was recovered. This was a portion of the base plug which had been sheared longitudinally, and the severity of the explosion was indicated by the fact that no such shearing effect had ever before been observed in shells exploded at this proving ground. All of these firings were conducted without an accident of any kind, except the setting fire to a quantity of the explosives by dropping an incandescent match upon it.

Nevertheless, the United States authorities were deterred from the adoption of these shell charges by accounts of accidents in other countries, which were claimed to be due to the formation of a sensitive compound through the action

of the explosive on the walls of the shell, though it was obvious that this could be prevented by the simple expedient of coating the walls of the shell with an inert asphalt varnish. However, the writer is convinced that navies hereafter will not only be provided with smokeless powder for their guns, but also with high-explosive charges for their shells, for the armour-piercing shells are now so strong that a full charge of gunpowder cannot burst them, and these very expensive projectiles would thus be no more efficient than solid shot.

It is true that the gunpowder-filled shells produced a marked incendiary effect both at Manila and Santiago, but the nitro-substitution compounds are equal to gunpowder in this respect when exploded by a gunpowder fuse. Yet if all inflammable material is to be removed from ships the incendiary characteristic will not count in the future as it has in the past. From all experience it seems assured that nitro-substitution compounds are the logical successors of gunpowder for charges for shells, to be thrown at high velocities from powder guns.

—Dr. Charles E. Munroe,
in *Cassier's Magazine*, December, 1898.

Through the kindness of the Cassier Magazine Company, New York City, we are enabled to reproduce, with Dr. Munroe's article, a series of illustrations, which adds to its interest.—*Ed.*

FORTIFICATIONS.

Defensive Works in Progress at Gibraltar.

It is satisfactory to learn that the new works, which were sanctioned by Parliament, for the extension of moles and dock accommodation at Gibraltar, as well as for the strengthening of the land defenses of "The Rock" itself, are progressing with the utmost rapidity. Several thousands of Spanish workmen have been employed during the spring and summer, most of whom live at Linea and other places outside the gates, and are shut out after gun-fire in the evening. It is somewhat unfortunate having to employ these Spanish artificers and laborers, whose intimate knowledge of the interior features of of works and batteries might, in the event of hostilities, supply a host of intelligent spies, who could afford valuable information to our enemies. Attila, King of the Huns, is said to have slain, wholesale, the workmen whom he employed in the erection of works whose nature it was desirable to retain a secret. We cannot follow his example; but it does seem to us a somewhat paradoxical arrangement to employ a quantity of foreign Europeans on works which are of such confidential character that Mr. Goschen himself had to obtain special sanction from the Secretary of State for War to visit them, whilst inspecting the progress of naval operations at Gibraltar. Indian coolies could do the business quite as well as Spaniards; and the money which was spent would thus return into the pockets of those who were at least subjects of the Empress Queen. As it is, it all goes elsewhere. When we speak of the "confidential character" of works, we do not, of course, allude to moles and breakwaters or docks, which possess no such attributes; but we learn that Spaniards have been employed in constructing the batteries and gun positions of a masked character, which are found scattered over the entire surface of "The Rock," from the North Front to Europa Point.

The "drift" which has been cut through the rock from the western side, where the bay is situated, to a spot near Catalan Bay on the east, is practically a tunnel large enough for locomotives and trucks to run through, and

several engines are actively employed in it, which convey stone and sand to the mole extensions and docks. By this means a vast quantity of material is being brought from quarries on the eastern side, and from the sand slopes, which descend at a sharp angle from the foot of the scarped precipices beneath the signal station to the Mediterranean shore, right through the rock to the bay, for conversion into great block of béton and mortar, also for the erection of walls and other masonry buildings. These sand slopes are practically inexhaustible. They are composed of fine silicious material, clouds of which are blown off shore and intercepted by the steep face of Gibraltar rock—1350 feet high and 3½ miles long—during the prevalent "Levanter" winds. Most of the old works at the North Front, which is a huge triangular face of rock 1300 feet high, facing the neutral ground, and surmounted by the old "Rock Gun Battery," are dismantled; and the famous long galleries cut through the solid rock, the highest of which terminated in a lofty hewn cavern called St. George's Hall, are now, alas, so far as military potency is concerned, works of a past age, and practically of little value. The King's, Queen's, and Prince's lines, which can be seen cutting sharp "straight-edges" out of the solid rock away on the left flank of the land-port gate, as we enter the fortress, are fitted for machine guns and small quick-firers, whilst a heavy battery of modern breech-loading guns occupies a position with high command near the old Moorish castle.

The Orange Bastion, King's Bastion, Jumper's Bastion, and other splendid works along the line walls, once terrible with their 32 and 68-pounder old smooth-bore pop-guns, which would rattle their spherical shot and shell harmlessly against the thinnest of modern armored vessels, are at last made useful as affording excellent emplacements for 6-pounder Hotchkiss and 12-pounder quick-firing guns, the latter being fitted with ample steel revolving shields 4 inches in thickness. But the best piece of work which has been recently done is the cutting out of a wide cart road, strong enough for the transport of the heaviest guns, and contrived to be at a gentle gradient, comparatively, right up to the signal station, to O'Hara's Castle, or rather to the site of it, and towards the "Rock Gun." By the aid of this new road a series of heavy masked batteries and separate gun positions has been constructed right along the slopes on the western side of the ridge, which runs from north to south. Some of these are grouped around the time-honored site known as the "Rock-gun Battery," dominating the North Front, where the two boys, called "Shot" and "Shell," were, according to Drinkwater's "History of the Siege," accustomed to sit and watch for the firing of mortars from the Spanish lines at Linea, giving notice by means of flag signals to the people in the town below, so that they might seek shelter from the coming projectiles. An especially powerful battery is mounted at the signal station, which will give ample cover to the exit from the "Drift," on the Mediterannean side, when it is required to be under gun protection. Towards O'Hara's Castle there are numerous groups. It is obviously inadvisable to give any particulars as to the grouping and nature of guns which occupy the several masked spots, but it may be mentioned that both 9.2-inch and 6-inch breech-loaders are there in large numbers, and that every group has its separate and masked position-finding cell and instruments, ranging up to 14,000 yards, some of the instruments at a high altitude being of the "depression" type, an almost unvarying base being obtainable at Gibraltar, as there is hardly any rise and fall in the tide.

The old batteries of 38-ton gun—muzzle-loaders - on the Alameda and over the town of Gibraltar, as well as at Europa, are still, we understand, to the

front, but the two 100-ton muzzle-loading guns, which had developed serious defects some six or seven years ago, are now, we are glad to say, replaced by two efficient weapons, which are mounted on the same spot, near the town and at Europa.

Two of the latest 9.2-inch guns are also, we learn, now in course of being mounted at Europa Point. They are 445½ inches in length, or 48.4 calibres. Their breeches are opened and closed by and with a balanced spindle, having a large steel ball opposite to the lever handle, in a far easier and more simple manner than the earlier 9.2-inch breech-loading guns. One man can work the breech with ease. They are, of course, of wire or steel tape construction. The weight of the projectile is 380 lb., and the muzzle energy 19,220 foot-tons. The range of these guns, if sufficient elevation be given to them, is very great. The artillery officers in charge of them at Gibraltar believe that they will effectively command the entrance to the Straits almost across to Ceuta.

Another very important item has been constructed. The water supply was found to be very insufficient, and a tank containing sufficient water for the entire garrison, and for the normal population of the town—those born on the rock—for a sustained siege, has at length been contrived in a hollow behind the town, which fills itself naturally, owing to artificial watersheds having been scarped along the faces and slopes around this hollow. This water has hitherto escaped into the hollows and recesses of the rock, such as St. Michael's Cave.

We learn that excellent arrangements have been made for the construction of secure and indestructible magazines for powder and explosives of various kinds. This is, of course, comparatively easy in a station such as Gibraltar, where you have only to blast out a hole to obtain a shelter that no hostile shot or shell can ever reach. But singular to say, for more than a hundred years the magazines of Gibraltar were mere houses ot thick masonry, with—so-called bomb-proof roofs. It it needless to say that no indication can be given in this article as to where the new magazines are situated. Unhappily, however, the site is well known to some three or four thousands of the descendants of Pizarro and Almazio.

—*The Engineer*, December 2, 1898.

MILITARY GEOGRAPHY.

The Present Status of the Panama Canal.

After the failure of the old Panama Canal Company in February, 1889, the property passed into the hands of a receiver, who, seeking to save from ruin the vast number of subscribers of moderate means, referred the technical problems to a "Comite d'Etudes" selected from among the best engineers of France. In May, 1890, this commission made an able report, indicating the numerous points which demanded further investigation before final plans could be judiciously adopted, but suggesting the general features of such a plan, based on a study of all existing data. To make these further investigations a new company was organized in October, 1894; and since that date it has quietly prosecuted its labors and has now collected all the information needed to command the confidence of engineers in its definitive project It is to set forth this project, and to indicate its superiority to anything possible in Nicaragua, that the present article is written. It may be proper to add that the writer, as a member of a technical commission of engineers, made last spring a careful examination of the entire route of the Panama Canal,

and is thus possessed of definite personal information, in some degree assisted by having formerly traversed Nicaragua. The following are the essential features of this project, endorsed, with some possible future modifications in details, by a Comite Technique, containing French, English, German, Russian and American engineers. Among them the chief engineers of the Manchester and of the Kiel ship canals.

The original plan contemplated placing the canal in the bed of the Chagres and conducting the river to the sea through artificial channels. This project was long ago definitely abandoned, being replaced by the familiar system of locks and dams which has been so often successfully applied to other rivers. Careful measurements and studies of the regimen of this torrential stream have shown the system to be entirely applicable to it, and that none of the constructions demanded will exceed the limits of recognized engineering practice. To these advantages it should be added that two good harbors already exist at the Atlantic and Pacific terminals; that an American railway is in active operation parallel and in close proximinity to the line of the canal throughout its entire extent; that about 40% of the whole length has been actually excavated, and that great progress has been made on the intermediate portions; and finally, that extensive preparations have already been made for accommodating the army of laborers which will be required on any Isthmian canal. These reasons certainly demand that the comparative merits of this route should be considered before adopting any other location for the canal now generally believed to be essential to meet the needs of our Atlantic and Pacific coasts.

In Nicaragua the general conditions are distinctly inferior. Two ports must be artificially prepared; one at least of great practical difficulty, since nature has already closed the old harbor. About 120 miles of railroad must be built, mostly traversing a wilderness. Almost nothing has been done in the way of construction or of preparation for the work. Of the whole length of 176 miles, 68 miles follow the bed of a crooked river, where the prevailing trade winds and the currents resulting from the whole outflow of Lake Nicaragua will unite to aggravate the difficulties of shipping in transit. The length of the route is about four times that of the Panama canal, adding proportionately to the time of passage; finally, at least one dam is demanded, quite without precedent in our canal construction, besides several miles of huge embankments in the San Francisco basin, where the foundations are extremely bad, and where a rupture at any future time would entail veritable disasters.

But passing from generalities, the details of the Panama project will first be considered.

The Canal Proper.—The total length is 75 kilometres (46.5 miles), of which five (3.1 miles) lie in the Bay of Panama, between Isle Naos and La Boca. Of the 70 kilometres (43.4 miles) of inland construction, 24 kilometres (14.88 miles) on the Atlantic side (between Colon and Bohio) and 7 kilometres (4.34 miles) on the Pacific side (between La Boca and Miraflores) will be at the sea level, and of this distance about 25 kilometres (15.5 miles) are now essentially excavated, thus there remains only 38 kilometres (23.5 miles) to be traversed by the aid of locks; and here also so much actual work has been done that no visitor can pass over the line without appreciating that the canal can no longer be regarded as an experiment.

Of these 38 kilometres between Bohio and Miraflores, the first 22 (13.64 miles) extending from Bohio to Obispo will traverse a vast lake 5500 hectares

(13,585 acres) in extent, created in the valley of the Chagres by a dam at Bohio. Its level above the sea will range between a minimum of 16 metres (52.48 feet) and a maximum of 20 metres (65.60 feet), the normal level being 17 metres (55.76 feet). A resevoir of 150 million cubic metres (52,950 million cubic feet) is thus provided to control in part the floods of the river. Access to the lake will be furnished by two double locks at Bohio.

There thus will remain to be considered only the 16 kilometres (10 miles) lying between Obispo, where the canal leaves the Chagres river and Miraflores, where sea-level is reached. This section includes the continental divide at the Culebra, approached on the side of the Atlantic by the valley of the Obispo, a tributary of the Chagres, and on the Pacific by the valley of the Rio Grande. The great economic problem to solve has been to determine the most advantageous level for the bottom of the canal between these two points, with a view to afford the best balance between the cost and the time of constructing the locks and dams on the one hand and deep cutting on the other.

This problem with its adjuncts of how to best supply the summit level during the dry season, how to regulate the floods of the Chagres during the rainy season, and how to provide hydraulic power for lighting and operating the canal at all seasons, has been most thoroughly studied on the spot by the new company since its organization in 1894. Space is lacking to detail the trial excavations, aggregating 3 million cubic metres, the surveys, the borings, the gagings of the water courses and the many other details which have been investigated in the most elaborate manner. Suffice it to say that, after comparative estimates of 16 variants, the Comite Technique has advised the adoption of a level of 20.75 metres (68 feet) above mean tide, which, should experience in the active prosecution of the work render it expedient, will admit of modification, either by adding two more locks, raising the level of the cut to 29.5 metres (97 feet), or of suppressing one or perhaps two locks, and thus reducing it to 10 metres (33 feet).

This definitive plan, placing the bottom of the canal at a level of 20.75 metres, involves two double locks at Obispo, raising the water surface at the summit level to a maximum of 31.25 metres (102.5 feet) and a minimum of 29.75 metres (97.58 feet); one double lock at Paraiso dropping these levels to 23.25 metres (76.26 feet) and 22.25 metres (72.98 feet); two double locks at Pedro Miguel, dropping them to 6.25 metres (20.5 feet) and 5.25 metres (18.22 feet); and a tidal lock at Miraflores, where the water level varies between 3 metres or 10 feet above, and 3 metres below mean tide. (On the Atlantic side the tidal oscillation is only a few inches, and no such provision is needful). The length of these levels in every case exceeds 2 kilometers (1.24 miles), thus avoiding trouble from oscillations due to lockages. In reference to the deep cutting at Culebra—the bugbear of former days—it is only needful to say that the excavation has already been carried below the level of the soft upper strata, which gives so much trouble by sliding, and is now and will continue to be in an indurated clay schist, requiring blasting, and passing to veritable rock. Serious trouble need no longer be apprehended here. This problem has been studied most thoroughly by the new company—involving the removal of about 2 million cubic metres of material, the sinking of many pits and borings, and the construction at the worst point of a tunnel 210 metres long (689 feet) at a level of 41 metres (134.5 feet).

In locating the line of the canal, great care has been taken to avoid abrupt curves. A minimum radius of 2500 metres (8200 feet) is adopted for the central cut, and of 3000 metres (9840 feet) for the rest of the line, except near

Bohio, where radii of 2500 metres and 2000 metres (6560 feet) occur in enlargements having a bottom width of 62 metres (203.4 feet), and near Obispo, where one radius of 1700 metres (5576 feet) occurs with a bottom width of 80 metres (262.4 feet). Even with the large standard curves adopted, suitable enlargements will be provided to render the route perfect in this important detail, in respect to which it is more favored by nature than either Kiel or Manchester, as appears from the following figures.

	Canals			
	Manchester.	Kiel.	Panama.	Nicaragua.
Total length, kilometres	54	98.6	74.5	284
Minimum radius, metres	571	1000	1700	......
Normal radius, metres	......	......	2500* / 3000†	1220‡ / 1311§
Length, straight	63%	63%	57%	......
Curvature :				
2500 metres or more	15%	......	41%	......
Less than 2500 metres	22%	......	2%	......
2000 metres or more	27%	29%	42%	......
Less than 2000 metres	10%	8%	1%	......

*Central. †Elsewhere ‡Eastern divide. §Western divide.

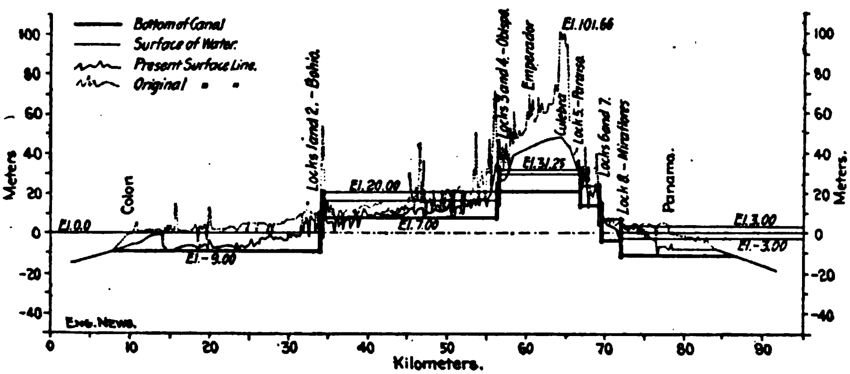


Fig. 1.—Profile of the Panama Canal; Bottom of Summit Level at Elevation 20.75 metres, or 68.06 feet above Datum.

LIFT OF LOCKS.

Atlantic Side.				Pacific Side.			
		Lift, feet.				Lift, feet.	
Location.	Order, No.	Maximum.	Minimum.	Location.	Order, No.	Maximum.	Minimum.
Bohio	1	32.80	26.24	Paraiso	5	29.52	21.32
"	2	32.80	26.24	Pedro-Miguel	6	29.52	26.24
Obispo	3	25.02	16.00	"	7	29.52	26.24
"	4	25.05	16.00	Miraflores	8	30.34	7.38

The cross section to be given the canal varies in different localities, as shown in the following table The depth is uniformly 9 metres (29.52 feet); and the side slopes usually 3 base to 2 height in earth, and 2 base to 3 height in rocky cuts. In respect to berms and revetments, the latest practice, as recommended by the recent International Congress of Engineers at Brussels, will be followed.

	Earth		Rocky cuts	
	Section, sq. m.	Bottom width metres.	Section, sq. m.	Bottom width, metres.
Colon to Bohio	406.5	30	380.2	34
Lake Bohio (minimum)	571.5	50	531.0	53
Summit level	379.5	36	379.5	36
Paraiso to Pedro-Miguel	406.5	30	380.2	34
Pedro-Miguel to Miraflores	406.5	30	380.2	34
Miraflores to La Boca*	720.0	30	....	...
Bay of Panama (low tide)	693.0	50	....	...

* Low tide.

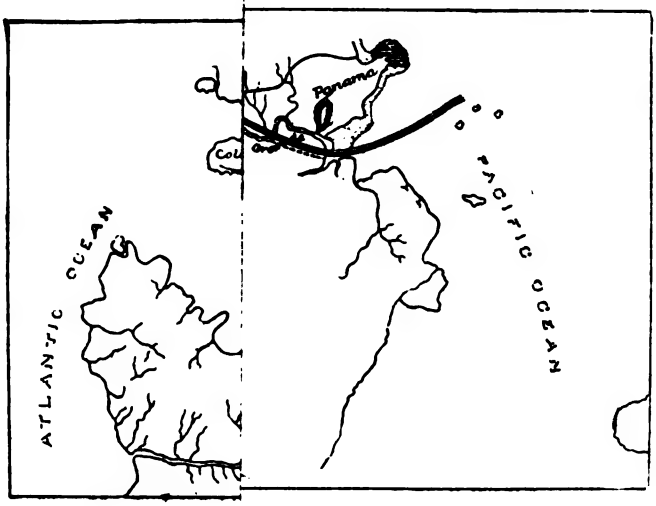
Enlargements 600 metres (1968 feet) long and 60 metres (196.8 feet) wide at bottom, to enable vessels to pass each other, will be provided in the canal at intervals of about 8 kilometres (4.96 miles); but immediately above and below the locks these dimensions will be raised to 700 metres (2296 feet), and 62 metres (203.4 feet).

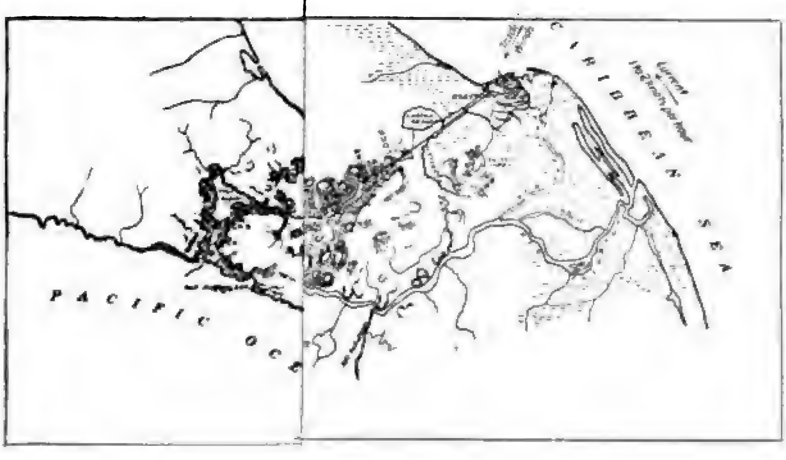
The Locks.—The locks, all founded on rock, are to be double, the larger chamber having a serviceable length of 225 metres (738 feet), a width of 25 metres (82 feet), and a depth of 9.5 metres (31.16 feet) at the sides, and 10 metres (32.8 feet) at the middle. The smaller chamber has the same serviceable length, with intermediate gates to reduce it to 130 metres (426.4 feet) when desired; a width of 18 metres (59.04 feet); and the same depth as the other. The larger will be constructed first, together with the foundations and head of the smaller, thus permitting the latter to be completed after opening the canal to traffic. The maximum lift has been fixed at 9 metres (29.5 feet), except at Bohio, where provision for 10 metres (32.8 feet) will be made, for use during extreme floods of the Chagres, which last only for a few hours.

The gates will be of the pivoted single leaf type, and water will be supplied by pipes buried in the lock floors and delivering on each side and throughout the whole length of the chamber, the flow being regulated by valves of the low level cylindrical pattern. Entrance to the chambers from either direction will be facilitated by crib piers, 60 metres long with detached heads to protect the structure from shocks.

The Dams.—There will be six dams, five located on the line of the canal at Bohio, at Obispo, at Paraiso, at Pedro-Miguel and at Miraflores, and one at Alhajuela, 16 kilometres (10 miles) above, on the upper Chagres. Of these only the first and the last need be considered, as the other four are minor affairs presenting no engineering difficulties (three of them are to be of masonry and one of earth).

The dam at Bohio will be of earth, abutting on conglomerate rock at the sides, and founded on a compact bed of clay, believed to be diluvial. The length of the crest will be 392 metres (1286 feet); the extreme height above the bed of the river, 23 metres (75.4 feet,) and above the foundation 28.5 metres (93 5 feet). The width at the crest which rises 3 metres (10 feet) above the highest level of the lake will be 15 metres (49.2 feet); the upstream slope has a height of 1 on a base of 3 with 4 berms each 3 metres (10 feet) wide, the whole riveted with stone laid dry; the downstream slope has a height of 2 on a base of 3, with one berm 3 metres wide, and is supported by a mass of loose rock rising to a sufficient height to protect the dam if, in spite of all precautions, it should chance to be overtopped by a sudden flood during construction. A puddled core, and a concrete wall at the upper toe, will cut off


ATLANTIC OCEAN
PACIFIC OCEAN
Panama


CARIBBEAN SEA
PACIFIC

any possible leakage. The mass of the dam will be of excellent material found in the close vicinity. During construction the river will be diverted through the rock cut for the locks, with ample provisions by deversoirs for combatting larger floods. All the details have been carefully studied and the project has received the unanimous approval of the Comite Technique.

The dam at Alhajuela will be of concrete masonry founded on and abutting against compact rock. The length of crest will be 285.5 metres (936.4 feet); and the height, 41 metres (134.5 feet) above the bed of the river and 50 metres (164 feet) above the deepest part of the rock foundations. The cross section conforms to the conditions of recent engineering practice.

To facilitate construction, a tunnel 300 metres (984 feet) long and 75 square metres (807 square feet) in cross section will be driven through the ridge to a bend of the river below, and a temporary dam will divert into it the minor flood discharges of the river. To meet the case of larger floods, the dam will be raised alternately on the two sides, thus allowing space for a portion to be overflowed without interrupting the work. These details have been carefully studied, and met the approval of the Comite Technique.

Engineers will recognize the immense advantages possessed by the Panama route in the matter of dam construction over the conditions found in Nicaragua, where the diversion of the San Juan river is admitted to be impracticable, and where the foundations present extraordinary difficulties and demand an unusual structure quite without precedent for canal purposes.

Regulation of the Chagres River.—This subject, comprising the control of the floods and the supply of the summit level, has received the elaborate investigation demanded by its importance. Space is lacking for details, but the general features are the following.

At Alhajuela the low water surface of the river is 28 metres (91.84 feet) above sea level; at Gamboa, 14 metres (46 feet); and at Bohio, 0 metres. The mean annual discharges at these three points respectively are 63 cubic metres (2224 cubic feet), 84 cubic metres (2965 cubic feet), and 121 cubic metres (4261 cubic feet) per second. During the three low water months (February, March and April) these mean volumes fall to 27 cubic metres (953 cubic feet), 31 cubic metres (1094 cubic feet), and and 39 cubic metres (1376 cubic feet), the minimum being 9 cubic metres (318 cubic feet), 10 cubic metres (353 cubic feet), and 14 cubic metres (459 cubic feet). The maximum flood volumes, closely estimated on the basis of the floods of 1879, the largest within the memory of the inhabitants, is at Gamboa, 1630 cubic metres (57,539 cubic feet) per second, and at Bohio 3100 cubic metres (109,410 cubic feet). The floods of the river, great and small, are all of the torrential type, resulting from the heavy and widespread tempests of the rainy season. Their duration is extremely short, rarely exceeding in the greatest floods 48 hours at Gamboa and 96 hours at Bohio. The maximum heights ever attained above the low water stage are about 11 metres (36.1 feet) at Gamboa, and 12 metres, (39.36 feet) at Bohio. These figures, resulting from years of patient and careful observations, have furnished the basis for solving the two great questions of river regulation presented by the problem of the canal.

Upon an estimate, known to be safe, of allowing 1000 cubic metres (35,300 cubic feet) per second to freely pass Gamboa and 1200 cubic metres (42,360 cubic feet) to freely pass Bohio, reservoirs to contain 1 million cubic metres (35,300,000 cubic feet) above Alhajuela, and 1.5 million cubic metres (52,950,-000 cubic feet) above Bohio are needful to restrain the greatest known floods:

and these reservoirs are provided by the dams already described. In no other than the flood of 1879 would so large volumes be demanded.

The level of these lakes is to be regulated by overflow weirs of the Stoney type, which have given perfect satisfaction on the Manchester canal, and which have the great merit of allowing the sills to be placed below the water surface without serious leakage.

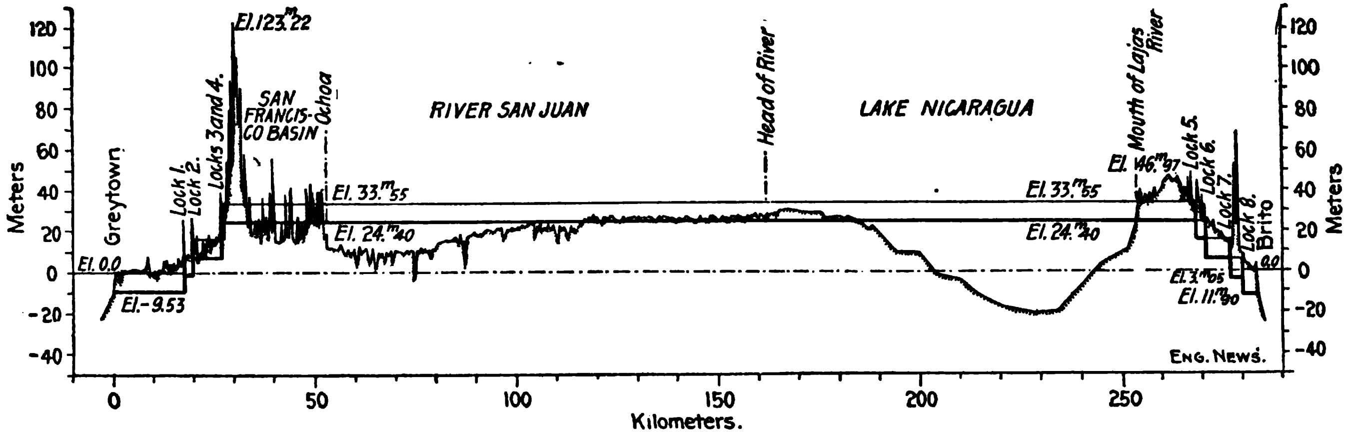
The volume of 1000 cubic metres (35,300 cubic feet) per second permitted to pass Alhajuela will follow the bed of the Chagres to Lake Bohio. The volume of 1200 cubic metres (42,360 cubic feet) allowed to escape from the latter, will pass by two overflow weirs—one to the left of the canal discharging 500 cubic metres (17,650 cubic feet) per second through the bed of the Chagres and its derivations; and the other at the sources of Rio Gigante discharging 700 cubic metres (24,710 cubic feet) by a route also separated from the canal.

To supply the summit level during the season of low water, the inflow of 20 cubic metres (706 cubic feet) per second will be required. To provide 7000 horse-power for lighting the canal and operating the gates, 15 cubic metres (530 cubic feet) per second are demanded, falling 32 metres (105 feet) at Alhajuela, and 15 metres (52.5 feet) at Bohio, and acting on turbines driving dynamos to transmit the power in the form of electricity. The reservoir capacity, in excess of the low water flow of the Chagres, to supply these two needs, is 130 million cubic metres (4589 million cubic feet). The area of the lake above Alhajuela is 2300 hectares (5750 acres) at the level of 61 metres (200 feet) above tide water and 3000 hectares (7500 acres) at the level of 65 metres (213 feet), the crest being 69 metres (226 feet), calling for a layer of water 9 metres (29.5 feet) deep to contain 1 million cubic metres for flood storage and 130 million for low water supply. Upon this basis the capacity of the lake has been regulated.

To transport the needful volume of water (20 cubic metres per second) from Alhajuela to the summit level, a feeder 16 kilometres (10 miles) long will leave the lake at a level of 58 metres (190.3 feet) above tide, and follow the left bank to a lateral valley, discharging gently into the summit level about a kilometre (0.62 miles) from the locks at Obispo. The fall between the lake and point of delivery will be 17 metres (55.8 feet) and the cross section is established to carry from 25 (882) to 40 cubic metres (1412 cubic feet) per second, with a view to meeting all possible contingencies of a largely increased traffic. At these heights water will flow into the canal even if the higher summit level should finally be found to be the more advantageous. The feeder traverses a difficult region and will be costly, but all details of construction have been successfully elaborated.

At Lake Bohio, as already stated, a capacity of 1.5 million cubic metres is needed for storage during great floods, and to assist the overflow weirs in regulating the level during the sudden influx of smaller floods. This volume calls for a layer of water 3 metres (10 feet) deep; and another metre has been added, to contain a reserve for supplying evaporation in the lake during the dry season.

From the foregoing it will be seen that the hydraulic problems presented by this turbulent river—at one time regarded as so serious—admit of satisfactory solution. This is hardly the case in Nicaragua, where one of the great difficulties of the project is the regulation of a summit level depending on that of an immense lake 2700 square miles in extent receiving directly the drainage of 8700 square miles of territory, together with that of 2250 square



Profile of the Nicaragua Canal; Bottom of Summit Level at Elevation, 24.40 metres, or 80.03 feet above Datum.

LIFT OF LOCKS.

Atlantic Side. Location.	No.	Normal lift, feet.	Normal level of bottom of canal above mean tide, feet. Lower.	Upper.	Pacific Side. Location.	No.	Normal lift, feet.	Normal level of bottom of canal above mean tide, feet. Lower.	Upper.
17.70 kilometres	1	26.00	0.0	26.00	268.60 kilometres	5	30.00	110.00	80.00
19.83 "	2	28.00	26.00	54.00	271.10 "	6	30.00	80.00	50.00
26.95 "	3	28.00	54.00	82.00	276.90 "	7	30.00	50.00	20.00
27.15 "	4	28.00	82.00	110.00	280.00 "	8	20.00	20.00	0.0

Note.—The height of tide being 1.25 feet on the Atlantic side and 8.9 feet on the Pacific side, the maximum lift of the locks at each end must be increased accordingly.

miles more through the tributaries of the San Juan river above the dam at Ochoa; conditions which render the ordinary method of storage reservoirs wholly inapplicable. Nevertheless a delicate regulation of this level, and at an artificial height, is essential to avoid on the one hand drowning a cultivated district on the west shore, and on the other hand exposing rocks in the navigable bed of the San Juan. These difficulties are aggravated by the necessity of placing the overflow weirs near Ochoa, at a distance of more than 100 kilometres (62 miles) from the lake.

In this connection it may also be noted that in the matter of rainfall the Panama canal is the more fortunate. All the difficult excavations and works of construction except those near Bohio lie in the interior where the annual downfall, as determined by 32 years of observation, is 93 inches, or only about 50% more than on our Gulf coast; while in Nicaragua, the most difficult constructions, including the Ochoa dam and the San Francisco embankments, lie in a district where the downfall, as determined from the data collected by the Nicaragua canal company (about 7 years' observations), is 256 inches, or nearly three times as much.

Estimates.—This subject has received the most careful study, both in determining quantities and unit prices. Much valuable data as to the latter, based on actual experience on the Isthmus has been available. The cost of each different project, and there have been 16 different variants, has been estimated in detail, and a selection between them has thus been reached intelligently. The sum needed for the work of construction proper is, in round numbers, one hundred million dollars. The element of time is more difficult to determine, but the volume remaining to be excavated at the Culebra being a little less than 12 million cubic metres (15,600,000 cubic yards). it is believed that ten years is a conservative estimate.

The Nicaragua Canal.—To the general relative merits of the two canals already considered may be added that the Panama route lies in the interior of Columbia, while that by Nicaragua lies near the Costa Rican boundary; where hostilities are liable at any time to cause difficulties, as they already have done during the canal examination by the Walker commission last spring. Also that in respect to danger from possible earthquakes, which might easily cause trouble at the great locks, Panama is by far the more safe, because no active volcano is found within a distance of at least 200 miles from it, while three lie in the close vicinity of the route of the Nicaragua canal, and one within only 40 miles of its western locks. Last April an earthquake destroyed substantial masonry buildings at Leon, only 100 miles distant from these lock sites.

But while it is thus easy to compare the two canals in their general features, and to see that the route by Panama is much superior to that by Nicaragua, when details are considered, we are confronted by the fact that really no definitive project can be claimed for the latter. The Company's project, as revised by the Government Commission, of which General Ludlow was president, is shown on the accompanying drawing; which may be compared with that given to illustrate the Panama project, but it should be noted that the latter has double the horizontal scale, thus failing to impress the eye, by fifty per cent., with its relative merit in respect to length. The data upon which this project was based were so unsatisfactory to the Ludlow Commission that they reported "for obtaining the necessary data for the formation of a final project, eighteen months' time, covering two dry seasons, and an expenditure of $350,000 will be required." A new commission has been appointed and

new surveys inaugurated; and it appears from the views of the individual members, as given before the select committee of the Senate in June, 1898, that the changes undergoing study are radical in their nature, and that, although some at least of the engineering difficulties which impressed the former Government Commission are recognized as grave, no means of avoiding them have yet been discovered. Under these conditions it is apparent that confidence cannot be accorded to such a project; and that really there is only one canal, that of Panama, whose construction could be judiciously undertaken at the present time. It is to be hoped before the Government embarks on so important a work that the relative merits of the two routes will be examined and judged by a commission of expert engineers, for it is certain that only one canal is now needed, and that that one should be the best possible.

(We are indebted to General Abbot for the profiles accompanying the above article. The two profiles have the same vertical scale; but the horizontal scale of the Panama profile is double the horizontal scale of the Nicaragua profile. The map of the Nicaragua Canal is produced from the map accompanying the report of the Ludlow Commission of 1895. The map of the Panama route is reproduced from a paper by Mr. Charles D. Jameson, M. Am. Soc. C. E., in the *Journal of the Association of Engineering Societies* for August, 1886).

—By GENERAL HENRY L. ABBOT, Corps of Engineers, U. S. A., in *Engineering News*, October 6, 1898.

WARSHIPS AND TORPEDO BOATS.

English Armored Cruisers.

Modern progress in the manufacture of artillery and the use of high-explosive shells, which have led to the adoption of a new type of warship in the French navy, the armored cruiser, have notably influenced English naval constructions planned in the latest programs. Up to last year the British navy possessed, as regards armored cruisers, only the seven vessels of the *Aurora* class built in 1886. These ships are of 5,600 tons displacement, have a speed of 18.5 knots, and carry side armor 250 mm. (10 inches) thick over two-thirds of their length.* But this armor rises only .45 m. (17.5 inches) above the theoretical water-line, and is almost always submerged on account of extra stores. Moreover, their guns have hardly any protection. Consequently, these cruisers are entirely different from the armored cruisers of to-day. They may be placed in the class of some other English cruisers, those simply "protected."

But if, as has always happened since the beginning of this century, the English are still behind us in this new stage of evolution of naval matériel, they are taking measures to outstrip us rapidly. Taught by our experiments, and due to their marvellous resources and manufacturing industries, it will be easy for them, unfortunately for us, to complete and arm a fleet of armored cruisers superior in numbers to ours before we can.

As in their battle-ships, it seems they desire to avoid the diversity of types to which our navy appears fatally doomed. In this year's budget the Admiralty possesses the necessary funds for commencing on four armored cruisers.

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* This class is composed of the *Aurora*, *Australia*, *Galatea*, *Immortalité*, *Narcissus*, *Orlando*, and *Undaunted*.

There are also two others, date, 1886; the *Imperieuse* and the *Warspite*, (displacement, 8,400 tons; speed, 16.7 knots; bunker capacity, 1,130 tons), which have been included in the "armored-cruiser" class.—A. H. JR.

In addition thereto, a few weeks ago, at the time of the appropriation of the semi-annual supplementary credits, the Admiralty asked for and obtained the necessary sum for the construction of four new cruisers of this description. Knowing the rapidity with which neighboring nations are building ships, they will probably have a fleet of armored cruisers well under way before we have finished either the *Jeanne d' Arc* or our cruisers of 9,500 and 7,700 tons.

The English armored cruisers will be of two types only. They will differ very little from one another except in the power of their engines, while ours are all dissimilar ships. Already, in fact, the armored cruisers that we possess, both on the stocks and at sea, may be divided into five classes, and it is very much to be feared that those which will be commenced next year will only accentuate this diversity still more.

The program adopted by the English Admiralty for its armored cruisers is very interesting. They have sought to evolve a ship possessing speed and a large steaming radius, fundamental qualities of the armored cruiser, but at the same time capable of fighting in squadron beside the ordinary battleship and resembling them as much as possible in their main characteristics. In this way the homogeneity of the naval fleet is preserved. Considerable importance is attached to this really important similarity, for it facilitates both squadron evolutions and the education of the *personnel*. Hence, the English armored cruisers are derived directly from battleships of the *Canopus* class. The difference of weight gained in the heavy artillery has been devoted to increasing the power of the engines. The distribution of the secondary batteries and the protection of the hull and guns are exactly the same.

The first class of armored English cruisers, those of the *Cressy* type, comprises six vessels.* They are 134 m. long, and 21 m. beam. Drawing 7.9 m. of water, they have a displacement of 12,000 tons, but under these conditions they carry only 800 tons of fuel. When their bunkers are full (containing then 2,000 tons of coal) their displacement is about 13,200 tons, a figure greater than that of the battleship *Renown*, and very nearly equal to that of the battleships of the *Canopus* class. Their length is greater than that of English battleships, as this does not exceed 120 m., and it is nearly the same as that of the protected cruisers of the *Ariadne* type, which were commenced after the trials of the *Powerful* and *Terrible*. These new ships are expected to have a speed of 21 knots, which corresponds to 21,000 indicated horse-power.

Their system of protection is in every way similar to that of battleships of the *Canopus* class. It consists of a central redoubt, formed by side armor, extending over a length of 70 meters, two armored traverses, a lower armored deck, and a splinter-proof deck at the level of the upper edge of the side armor. The side armor is 150 mm. (6 inches) thick; it is supported by a teak backing 100 mm. in thickness. Its height is about 3.5 m.: 1.5 m. below the water line and 2 m. above. Armor 50 mm. thick placed directly on the sides and extending all the way to the stem, continues this side armor forward. Towards the stern, on the contrary, the sides are not armored, but in this part of the vessel the thickness of the side plates has been sensibly increased. The armor of this central redoubt and of the decks is of less thickness than that of the *Majestic* and *Renown*, but it has almost exactly the same relative dimensions as that of the *Canopus*. Moreover, it is to be observed that recently-made progress in the manufacture of armor plate makes it possible to greatly reduce thicknesses adopted five or six years ago, at the same time

* *Four*, according to other authorities: The other ships of this class will be the *Aboukir*, *Hague*, and *Sutlej*.—A. H. JR.

preserving the same power of resistance. On the whole, as regards protection, the armored cruisers of the *Cressy* class are almost on the same footing as the English battleships.

Their armament is as follows:

2 23 cm. (9.2-in.) guns, weighing 22 tons.
12 152 mm. (6-in.) rapid-fire guns.
17 various small calibers.
2 submerged torpedo-tubes.

The distribution of these pieces is exactly the same as in the battleships. The two large pieces are mounted in two armored barbette turrets, 150 mm. thick, and provided with revolving shields of the same thickness. These barbettes are situated at the ends of the central redoubt, inside of the armored traverses. The 152 mm. guns are mounted along the sides in armored casemates 150 mm. thick; eight are placed on the splinter-proof deck and four on the upper deck.

If, as regards heavy artillery, this armament is quite inferior to those of the *Majestic* or *Canopus* classes, which have each four 30 cm. guns—indeed even to that of the *Renown*, composed of four 254 mm. guns—it consists of exactly the same secondary artillery as these latter carry. Moreover, this artillery is mounted and protected in the same manner on the cruisers and on the battleships. As on the *Canopus*, four 152 mm. guns can fire directly ahead and four directly astern together with one of the large pieces.

Two armored conning-towers 300 mm. thick are installed, one behind each turret. They accentuate still more the similarity between these ships and the English battleships. However, the Admiralty has endeavored to give them the appearance of cruisers. They will resemble very much, it seems, the *Ariadne* class, especially on account of their four funnels.

Their motive power will consist of two triple-expansion engines, with four cylinders, and thirty Belleville boilers. It is to be noticed that since English naval ship-building companies have commenced to construct multi-tubular boilers, the Admiralty has completely discarded, so to speak, boilers of the usual marine type as well for battleships as for cruisers.

The latest two English cruisers resemble those of the *Cressy* class, but they are larger, and have a speed of 23 knots. They are 151 metres long, of 21.5 m. beam, draw 7.9 m. of water, and have a displacement of 14,000 tons. Their engines are to develop 30,000 horse-power, and their bunkers can hold 2,500 tons of coal. Their armor and the protection of the guns are identical to those of the cruisers of the *Cressy* class. Their armament is distributed in the same manner, and is composed of the same calibers. The only difference is in the number of 152 m. guns. There are 16 of these on the 23-knot cruisers.*

In comparing this summary description of the new English armored cruisers with the description of the *Jeanne d'Arc* and of our cruisers of 9,500 tons, it is immediately seen that the English cruisers are less specialized than ours. Between a *Canopus* and a *Cressy* the difference is very much less than between a *Carnot* or a *Charlemagne* and the *Jeanne d'Arc* or one of the armored cruisers of 9,500 tons. As we have often stated, the English have succeeded in avoiding diversity of types in their fleets. This diversity is, in fact, a source of weakness. It renders difficult and complicates the education of the personnel. Moreover, it is very evident that in a squadron dissimilar vessels cause inconvenience to one another. Evolutions as a squadron generally oblige the ships

* According to the *Scientific American*, *four* of the cruisers are to be of this design.—A.H.JR

composing it to fight and receive the enemy in similar positions. Now, this position will not be equally advantageous for all the ships if they are not very nearly alike, therefore there will be points of weakness in the front of attack or defense. The almost absolute similarity of the ships of the *Royal Sovereign*, *Majestic*, *Canopus* and *Formidable* classes, as regards the composition and distribution of their artillery, proves that the Admiralty attaches importance to possessing homogeneous squadrons. Fleets of former days were all so. The English have plainly sought to cast their armored cruisers in a common mould, and to construct them in such a way that they might figure beside a *Majestic* or a *Canopus*. It is evident also that a *Cressy* will offer the same resistance as a *Canopus*, since it possesses the same protection. But considering its great inferiority in heavy artillery, it could not do the same work, and its superiority in speed would serve to no good purpose in a fleet.

Now, the weakness of a line of battle results as well from defects in offensive measures as in defensive. The English-armored cruisers, although larger and costing more than ours, are really less well adapted to the special rôle of "skirmishers" for the fleet. Their artillery is, perhaps, slightly superior in caliber or in number of guns to that of our *Jeanne d'Arc* or that of our cruisers of 9,500 tons. But it could sustain a duel with a battleship's artillery no better than ours could. The difference, besides, is quite small.

It is not the same, though, as regards protection. The armor of the central redoubt of the English armored cruisers is, it is true, of the same thickness, 150 m., as the belt of the *Jeanne d'Arc* or that of our 9,500-ton cruisers; it even rises to the height of the splinter-proof deck, while on our cruisers only a thin belt surmounts the 150 mm. belt. But if the central region of the English cruisers is a little better protected than ours, the armor protection of their ends leaves much to be desired. It consists only of thin armor extending over a small portion forward, and there is none at all, so to speak, towards the stern. This arrangement, which is found in most all English warships, appears particularly open to criticism, we think, when ships are concerned, which especially ought to fight, both in chasing and running away.

Trans. by A. H. Jr. —*Le Yacht*, September 3d, 1898.

The "Ikadsuchi."

On the opposite page we give a view of a torpedo-boat destroyer, built by Messrs. Yarrow and Company, Limited, for the Imperial Navy of Japan. This vessel ran a preliminary trial on the 16th inst. over the Maplin measured mile with remarkable results, and it may here be stated that our illustration is a reproduction of a photograph taken from a tug when the vessel was actually travelling at over 31 knots, the exposures of the plate having been made when the vessel was on the mile. The *Ikadsuchi*, for that is the vessel's name, is the first of six similar craft built by Messrs. Yarrow and Company for Japan. She is a twin screw boat 220 feet long and 20 feet 6 inches wide, and is propelled by two sets of four-crank triple-expansion engines, which are balanced on the Yarrow, Schlick and Tweedy principle; this method, as our readers are aware, has been adopted with considerable success by builders of larger vessels. It may be added that on the trial of the *Ikadsuchi* the running was exceedingly steady at all speeds. In each set of engines the high-pressure cylinder is 20½ inches, the intermediate cylinder 31½ inches, and the two low-pressure cylinders each 34 inches in diameter, the stroke being 18 inches. In accordance with the usual practice now followed by this firm,

The Torpedo-Boat Destroyer *Ikadsuchi* for the Imperial Japanese Navy.

the two low-pressure cylinders are placed at the ends of the set. There are four boilers of the Yarrow straight-tube type.

It will be seen from the illustration that in general appearance the vessel is of the usual type of destroyer built by this firm ; but in the internal arrangement there is an important modification in the fact that the officers' quarters, in place of being right aft, as in British vessels, are placed nearer amidships. This is certainly an improvement so far as the officers are concerned. In the machinery department one or two clever improvements in detail have been introduced, but as we shall deal more fully with these boats when the official trials come on, we may leave these matters for the present. On the trial made on the 16th inst., the contract load of 35 tons was carried, and the contract speed of 31 knots was more than reached during four runs on the mile, without pressing the machinery. The engines are designed to give 6000 horse-power, but it was shown by the trial that an ample margin has been allowed, and it is estimated that 7000 indicated horse-power could be reached if needed. The steam pressure on trial averaged 185 pounds per square inch with easy blowing. The revolutions were 410 per minute, and the draught 8 feet 6 inches. The armament will consist of one 12-pounder quick-firing gun mounted aft, and five 6-pounder guns. There are two torpedo guns on deck for 18-inch torpedoes. The coal capacity is 90 tons, which is amply sufficient to take the vessel across the Atlantic at a fair speed. The official trials of these six vessels will take place during the new year, and to judge by the trip made with the *Ikadsuchi* the Japanese authorities need have little doubt that Messrs. Yarrow and Company will amply fulfil the certainly onerous conditions of their contract, and more than reach the exceptional speed promised.

—*Engineering*, December 30, 1898.

BOOK REVIEWS.

Ulysses S. Grant, his Life and Character. By Hamlin Garland. New York: Doubleday & McClure Company. 1898. Pp. xix. 524. Price, $2.50.

This book, as the author states in his introduction, is not to be taken as a military history of General Grant. It is not, perhaps, everything that is understood by the word "biography," but it tells the story of Ulysses Grant from his birth to his death. "It has not been my intention to set down all the significant words and deeds of General Grant, nor to analyze all the official acts of President Grant, but to present the man Grant as he stands to-day before unbiased critics."

The result is, we think, one altogether successful, for throughout the book what most impresses one is the personality of the *man*.

The plan of the volume in brief is this: The first chapters take up the development of Ulysses Grant from his birth to his appointment to West Point, presenting whatever seems significant of his life at the Military Academy; then pass to his experiences in the Mexican war, which formed his post-graduate course, and marked his first introduction to national questions and to military intrigues.

The period of his failure in civil life is then studied, presenting the man as nearly as possible as he appeared at that time to his family and to his friends, after it seemed that his career as a soldier had ended. One cannot help being touched and feeling sympathy for "the prematurely bent, care-worn, and sombre man of thirty-five."

The next section, the period of the civil war, is not intended as a history of Grant's campaigns, but the story of his growing command and his marvellous development during those four epic years. His motives for action and the simple straightforwardness of his course form also the basis of the delineation of the reconstruction period and of Grant's administrations.

The author throws new light on some of the events in the personal history of General Grant before the war. Forecast and prophecy are purposely avoided, but characteristics of the man strike one in his early life. As a boy, "his unusualness was in the balance of his character, in his poise, his mature judgment, and in his knowledge of things at first hand."

His career at West Point and during the Mexican war is graphically described. "From a military point of view, these years of active service were of incalculable value. They formed his post-graduate course. They made theories of his instruction at West Point realities. He saw two really great commanders work out maneuvers of unquestioned brilliancy. He saw Scott cut loose from his base of supplies and subsist on the country. He saw Taylor flank the enemy at Monterey, and watched him under fire, cool, unhurried. He observed Scott co-operating with gun boats and directing artillery. * * * From Taylor he learned the lesson of simplicity in army regulation, from Scott, rigorous discipline. * * * He perceived the difference between disciplined troops moving under one man's direction and many troops operating on lines not converging to a common purpose. All these things he saw, and they sank deep into his impressionable mind. * * * That it broadened his thought and developed his power is without doubt. He had grown

in resource, energy and in military technique. He knew the actualities of war. In his impressionable period he came in contact with two admittedly great generals, and faced both volunteer and regular troops."

The author enters more fully than any one else has done into the details of Grant's experiences during the days of his humiliation. "The volume does not hesitate to present the deep shadows of the picture as well as the high lights, for they are correlative. Ulysses Grant had his defeats and his sorrows He had his weaknesses as well as his great qualities, and they are frankly stated." But "those dark days were days of preparation, of growth. In this six-year struggle great powers of thought, of reserve, of concentration were developed. His conspicuous weakness in certain directions made him watchful and kept him sympathetic. His poverty made him understand men. His life with slaves and slaveholders gave him the key to their motives and to their conception of the great slavery question. The black man he knew by personal contact; the slave-owner he had known as neighbor."

About 138 pages of the work are then devoted to the period from the time Grant was made Brigadier-General of Volunteers to the surrender at Appomatox. The author avoids so far as he can battle descriptions and military criticism and confines himself to the story of Grant's remarkable personality during that time. Although not of great value in a strictly military sense, the work offers some contributions to those teachings of experience so greatly needed at this time and for the future. When about to be made Commander-in-Chief, "he feared the politicians, the schemes, the influences of the capital. * * * On his way to Washington he went carefully over the situation once more. He had observed from the first the lack of harmony in the movement of the armies of the North. * * * The failure to co-operate had led to disaster, whereas concerted action led to victory at Vicksburg and snatched victory out of defeat at Chattanooga. * * * Carrying these facts in his mind, Grant determined to demand of President Lincoln the assurance that the War Department should cease to command in the field. The War Department was an administrative office. The Secretary of War was a civilian, not a soldier, a political appointment, and not a military chieftain. * * * General Grant made up his mind to say to Lincoln: 'I will accept the command of the armies of the United States provided I can be free from the interence of the War Department; otherwise I shall be obliged to decline the honor.'"

"It is a significant fact," as Colonel Henderson says (in the life of a leader whose career bears a curious resemblance to Grant's), "that during the war of Secession, for the three years the control of the armies of the North remained in the hands of the Cabinet, the balance of success lay with the Confederates. But in March, 1864, Grant was appointed Commander-in-Chief; Lincoln abdicated his military functions in his favor, and the Secretary of War had nothing more to do than to comply with his requisitions. Then, for the first time, the enormous armies of the Union were maneuvered in harmonious combination, and the superior force was exerted to its full effect."

As a commander, General Grant's most marked characteristics were "measureless persistence, swift and unhesitant action, calm mastery of details, considerateness in the treatment of subordinates, courage to assume responsibility, and beyond and perhaps above all, the capacity to do, in the heat and tumult of war, things so conspicuously right that when the battle is ended they seem to have been inspired by a miraculous common sense."

The chapters on Grant's administrations attempt to show that President

Grant pursued a simple, straightforward course. He had in him small capacities for deceit or dishonesty. Throughout his life he remained practically the same simple-minded and sincere man.

Mr. Garland has devoted much time to the study of his subject, having visited every place where General Grant ever lived and interviewed all Grant's intimate friends and those persons who knew him personally and had some significant message to impart. By these original researches, by his skill in marshalling facts and his ability as a delineator, he has furnished, in this characterization of the man, an interesting contribution to the existing literature on the life and character of this "great warrior of peace."

A. H. JR.

Ueber die Grundlagen des Shrapnelschiesses bei der Feldartillerie, von Calllenberg, Lieutenant-Colonel, Instructor at the Artillery and Engineer School. I. The Reliability of Range-finding shots with percussion-fuse fire. Berlin: E. S. Mittler und Sohn, 1898. Marks 3.

The work of Lieutenant-Colonel Callenberg is primarily a discussion of the general subject of the reliability of the range-finding shots as conducted according to the firing regulations, but, incidentally, the author defends the regulations and disputes the conclusions arrived at by Lieutenant-General Rohne in his able articles on the same subject.

The history of this discussion takes us back to the German Artillery Firing Regulations of 1890,* on which the then Colonel Rohne based his Artillery-Fire Game,† which, while based on the Firing Regulations, nevertheless criticises certain directions therein contained. After this Captain Magnon took up the subject in the *Revue de l'Armée Belge*, July-August, 1896, and deduced a method of calculating the probability of field artillery fire, his work supplementing that of Rohne and verifying his deductions.

In 1897 General Rohne, inspired by the article of Captain Magnon, proceeded to study the reliability of range-finding shots, as prescribed by the regulations, and published his results in the *Archiv für die Artillerie und Ingenieur-offiziere*, May-June, 1897.‡ In this investigation General Rohne comes to the conclusion that of the 200 meters forks 29.3 % will be wrong, and of the 100 meter forks 47.4 % will be wrong, and when firing with time fuse is opened after this, then for both forks about 20 % of the shrapnel will be lost.

In the present work Lieutenant-Colonel Callenberg takes up the subject, and after stating that such a large percentage of waste shots would be entirely inadmissible, proceeds to prove that the percentage is in reality much lower, indeed, as low as 10 %. His conclusions are based on more recent and on a much greater number of shots than those of General Rohne, and while his method is practically the same, his deductions, due to the difference in data obtained, are quite different.

The work is so arranged that those readers who do not desire to follow the author's reasoning and are willing to accept his deductions can omit all the mathematical work and still obtain a clear idea of the subject from the descriptive part alone; while those inclined to enter into the subject more closely are furnished with all the material necessary to judge of the value of the author's work.

The position of the author as instructor at the great Artillery and Engineer

* *Schiessvorschrift für die Feld-Artillerie.* 1890. Berlin: E. S. Mittler, und Sohn.

† See *Journal U. S. Artillery*, Vol. II, pp. 122, 260, 383, 608.

‡ See *Journal U. S. Artillery*, March-April, 1898.

School for Officers is a guarantee of the importance of this work, and the labor involved in the collection of the great number of data obtained from actual firing, as well as the pains taken to consider with scrupulous care all causes of error, are an evidence of the excellence of the method and of the value of the deductions.

The interest of our own officers in this subject has been comparatively small, principally on account of the small number of rounds allowed for the annual target practice of field batteries. Still, with our latest Light Artillery Drill Regulations as a basis, and the work of General John I. Rodgers (Colonel Fifth Artillery) to supplement them, much can be accomplished. A thorough study of the subject is, however, all the more essential, since our means of actual firing experience are so limited, and the work of Lieutenant-Colonel Callenberg is strongly recommended to that end.

In conclusion, and in the same connection, the Editor calls attention to the leading article of this number of the *Journal* as well worthy of study and discussion, and trusts that our Light Artillery officers will take up this interesting matter, so modestly presented by the Professor of tactics at Woolwich.

J. P. W.

Mémoire sur les Vibrations Elastiques et la Resistance des Canons, par M. F. Gossot, Lieutenant-Colonel de l'Artillerie de la Marine, et M. R. Liouville, Ingenieur des Poudres et Salpêtres. Paris: Imprimerie Nationale. 1897. Pp. 93.

The usual "shrinkage" formulae for modern guns are based on conditions of elastic equilibrium of a cylindrical tube. It is supposed, in order to establish these conditions, that a constant and uniform pressure is exerted on each limiting cylindrical surface, and that equal and opposed stresses, also constant and uniform, are exerted on the extreme transverse plane sections.

As a fact, in the case of cannon, the problem is quite different: the interior pressure and the longitudinal stress on the breech section are functions of time; the "pull" on the muzzle section reduces to zero. There is no reason to suppose *a priori* that the deformations thereby produced bear any analogy to those where equilibrium obtains.

This difficulty has been already mentioned by General Virgile. The two extreme cases are: 1. Where the gaseous pressure develops so slowly that, at each instant, equilibrium takes place between this pressure and the elastic resistance of all the layers of metal; and, 2. Where the pressure *suddenly* reaches a maximum and remains at that point a certain time. In practice the powder pressure is rapid, but it is not instantaneous. The resulting deformation must be placed between those corresponding to these extreme cases.

The use of slow-burning powders has now become general. Hence, it may be that the increase of pressure is gradual enough for static deformation to take place in such manner as to render the shrinkage formulæ sufficiently exact.

This is the question that MM. Gossot and Liouville investigate in the present work. They consider a simple tube subjected, as we have said before, to a superficial pressure, which is a function of time. By rigorous analysis they determine, according to the theory of elasticity, the resulting deformations. The whole subject is entered into and treated most thoroughly.

The authors find that the displacement of any particle may be regarded as the resultant of many others: One, the static displacement, is independent of

the time; to this is added a periodic movement of known period and amplitude, and finally a great number of periodic movements, which form the vibrations proper of the gun. The amplitude of these vibrations is negligable, however, so that there remain only the static displacement and the principal periodic movement, the maximum elongation of which is very nearly equal to this displacement. As a result, it is found that the maximum radial strain, neglecting an inappreciable difference, equals the strain which would be the result of equilibrium under a constant pressure equal to the maximum.

As regards the longitudinal displacement, it is found a movement takes place that may be regarded as formed by a series of waves propagated in the tube and reflected from each extremity. The calculations show that under the ordinary conditions of construction and loading, the deformation produced, which is a maximum at the breech, differs very little from that which would be produced by a uniform pressure, equal to the maximum, and two opposed, uniform stresses developed thereby.

Hence for the longitudinal, as well as for the radial strain, the tube constitutes an elastic system which, in opposing the forces applied to it, undergoes certain deformations. The numerical differences between the displacements that actually occur and those from the supposed conditions of static equilibrium, are so very small that they can be neglected; so that the definite results of these researches imply the correctness of the formulæ used at present in the manufacture of artillery.

This result is of great importance. To obtain it the authors have displayed great talent as analysts and extreme ability in the arduous and complicated calculations rendered necessary for the verification of their results.

E. S.

(From the French.—A. H. JR.)

Photographic Mosaics. An Annual Record of Photographic Progress. Edited by Edward L. Wilson. Thirty-fifth year. New York: Edward L. Wilson. 1899. Pp. 288.

The thirty-fifth issue of this annual contains many valuable articles by prominent amateurs and eminent photographers, with a collection of pictures fairly representative of the best professional work of the year.

The familiar features of past volumes of *Mosaics* are all retained in the present volume. Improvement will be noticed, however, in the condensation and more careful selection of the reading matter to provide room for a larger variety of illustrations.

Section I, "a glance at photographic progress in 1898" if full of information for all those interested in photography. It contains notes and comments on all that is new in the art; developers, printing methods and formulæ, papers, etc., and cannot fail to be of value to the progressive photographer who desires to keep up with the times.

The original contributions, forming Section II, form interesting reading and help in a large measure to make the volume what it is, "the favorite year-book of the American photographer." A. H. JR.

Armor Plate. Ballistic Tests of Armor Plate as manufactured by the Carnegie Steel Company, Limited. Pittsburg, Pa., U. S. A., 1898. Pp. 73.

This excellently well printed and splendidly illustrated description of various ballistic tests of armor plate made by the Carnegie Company is indeed a work of art, and goes far towards showing the excellence of their product

The work is mainly a series of illustrations: Large full-page photo-gravures that are beautiful. The armor plates tested are shown, most of the vessels of the U. S. Navy, and then some miscellaneous views of armor plate processes at the works, interiors of shops, and the machines and presses used in the manufacture of armor plate.

The tests described are some that have been made in the past few years on armor for our ships and foreign governments. The excellence of the results obtained may well cause us to feel proud of this, our great armor-making plant. A. H. Jr.

Reprint of the Squadron Bulletins of the North Atlantic Squadron, with an introduction, by Rear-Admiral Sampson. New York: Doubleday and McClure Company. 1898. Pp. 101. With Index.

The Doubleday and McClure Company have issued in unpretentious form this series of *Squadron Bulletins* that forms a very interesting if not important, chapter in the history of the late war. The *Squadron Bulletin* was first published on board the U. S. Flagship *New York* on June 14, 1898. Scattered around the Island of Cuba were the ships of the squadron, cut off, for the most part, from all news and with few means of communication. It was with the idea of relieving the monotony of blockading routine and of affording the officers and men of the fleet an opportunity to learn the daily progress of the war that the bulletin was issued.

The many requests for complete sets and missing numbers has led to the republication of the entire series. Admiral Sampson states that whatever profit may result from the sale of this reprint will be donated to the proposed Sailors' Rest, Brooklyn. A. H. Jr.

Revista Militar y Naval, Redaccion Calle Colonia, No. 379 A. Montevideo, Uraguay.

This new *Military and Naval Review* issued its first number in November, 1898, and will appear on the 10th and 25th of each succeeding month. Its aim is to devote itself to the military and naval interests of the Republic; the reorganization of the army and navy, the National Guard, foundation of a naval school, and other reforms, and to keep in touch with all military and naval progress.

The *Revista* appears in the form of a well-printed pamphlet of about twenty pages, of the size of our page. We greet it with our best wishes for the success of its undertaking. Ed.

BOOK NOTICES.

[These books will be *reviewed* as space becomes available.]

Field Artillery: Krupp Guns, 7.5 *cm.* *L*/28. Articles published in the *Journal do Commercio*. By General of Division, Dr. F. C. da Luz Professor *emeritus*, former Superior War College. Rio de Janeiro. 1898. Pp. 92.

Wellington and Waterloo. By Major Arthur Griffiths. With an introduction by Field-Marshal Viscount Wolseley, K. P., etc., Commander-in-Chief of the Army. London: Published by George Newnes, Limited, 10–12, Southampton Street, Strand, W. C. 1898. Pp. viii., 280. With numerous illustrations. Price, 10s., 6d.

INDEX TO CURRENT ARTILLERY LITERATURE.

PERIODICALS CITED.

Abbreviations employed in index are added here in brackets.

All the periodicals are preserved in the Artillery School Library, Fort Monroe, Virginia.

ENGLAND.

Aldershot Military Society. *Occasional.*
Aldershot. Copies 6d each.

Arms and Explosives. [*Arms and Ex.*] *Monthly.*
Effingham House, Arundel Street, Strand, London, W. C. Per year 7 *s.*

Army and Navy Gazette. [*A. and N. Gaz.*] *Weekly.*
3 *York Street, Covent Garden, London. Per year* £1 12*s* 6 *d.*

Canadian Military Gazette. [*Can. Gaz.*] *Fortnightly.*
Box 2179 *Montreal, Canada. Per year* $2.00.

The Engineer. [*Eng.*] *Weekly.*
33 *Norfolk Street, Strand, London. Per year* £2 6 *d.*

Engineering. [*Eng'ing.*] *Weekly.*
35-36 *Bedford Street, Strand, London, W. C. Per year* £2 6 *d.*

Journal of the Royal United Service Institution. [*Jour. R. U. S. I.*] *Monthly.*
17 *Great George Street, London, S. W. Per year* 24 *s.*

Journal of the United Service Institution of India. [*Jour. U. S. I. India*] *Quarterly.*
Simla, India. Per year $2.50.

Photographic Journal. [*Photo. Jour.*] *Monthly.*
12 *Hanover Square, London.*

Proceedings of the Institution of Civil Engineers. [*Proceedings I. C. E.*]
25 *Great George Street, Westminister, London.*

Proceedings of the Institution of Mechanical Engineers.
[*Proceedings I. M. E.*] 19 *Victoria Street, Westminister, London.*

Proceedings of the Royal Artillery Institution. [*Proceedings R. A. I.*] *Monthly.*
Woolwich, England.

Professional Papers of the Corps of Royal Engineers.
[*Prof. Papers Corps Royal Eng'rs.*]
Chatham, England.

Review of Reviews. [*Rev. of Rev. Austral.*] *Monthly.*
169 *Queen Street, Melbourne, Australia. Per year* 11 s. 6 d.

Transactions of the Canadian Institute. [*Trans. Canadian Inst.*]
58 *Richmond Street, Toronto, Canada.*

Transactions of the Canadian Society of Civil Engineers.
[*Trans. Canadian Soc. C. E.*]
Montreal, Canada.

Transactions of the East of Scotland Tactical Society.
[*Trans. E. of S. Tactical Soc.*]
51 *Hanover Street, Edinburgh, Scotland.*

Transactions of the Institute of Naval Architects.
[*Trans. Inst. Naval Architects.*]
5 *Adelphi Terrace, London, W.C.*

United Service Gazette. [*U. S. Gaz.*] *Weekly.*
10, *Wine Office Court, Fleet Street, London, E. C. Per year* £1 10 *s* 6 *d.*

United Service Magazine. [*United Serv. Mag.*] *Monthly.*
13 *Charing Cross, S. W. London. Per year* 27 *shillings.*

FRANCE.

Le Génie Civil. [*Génie C.*] *Weekly.*
6 *Rue de la Chaussée d'Antin, Paris. Per year* 45 *Fr.*

La Marine Française. [*Marine F.*] *Semi-monthly.*
23 *Rue Madame, Paris. Per year* 30 *Fr.*

Mémoires et Compte Rendu des Travaux de la Société des Ingénieurs Civils.
[*Ingénieurs Civils.*] *Monthly.*
10 *Cité Rougemont, Paris. Per year* 36 *Fr.*

Mémorial des Poudres et Salpêtres. [*M. Poudres et S.*] *Quarterly.*
Quai des Grands-Augustins, 55, *Paris. Per year* 12 *Fr.*

Le Monde Militaire. [*Monde.*] *Fortnightly.*
76 *Rue de Seine, Paris. Per year* 6 *Fr.*

Revue d'Artillerie. [*R. Artillerie.*] *Monthly.*
5 *Rue des Beaux-Arts, Paris. Per year* 22 *Fr.*

Revue de Cavalerie. [*R. Cav.*] *Monthly.*
Berger Levrault et Cie, Rue des Beaux-Arts 5, *Paris. Per year* 33 *Fr.*

Revue du Cercle Militaire. [*Cercle.*] *Weekly.*
37 *Rue de Bellechasse, Paris. Per year* 27 *Fr.*

Revue du Génie Militaire. [*Génie M.*] *Monthly.*
8 *Rue Saint-Dominique, Paris. Per year* 27 *Fr.*

Revue d'Infanterie. [*R. Inf.*] *Monthly.*
11 *Place Saint André-des-Arts, Paris. Per year* 25 *Fr.*

Revue Maritime. [*R. Maritime.*] *Monthly.*
L. Baudoin, Rue et Passage Dauphine 30, *Paris. Per year* 56 *Fr.*

Revue Militaire de l'Etranger. [*Etranger.*] *Monthly.*
L. Baudoin, Rue et Passage Dauphine 30, *Paris. Per year* 15 *Fr.*

Revue Militaire Universelle. [*R. Univ.*] *Monthly.*
11 *Place Saint André-des-Arts, Paris. Per year* 25 *Fr.*

Le Yacht—Journal de la Marine. [*Yacht.*] *Weekly.*
55 *Rue de Chateaudun, Paris. Per year* 30 *Fr.*

GERMANY.

Allgemeine Militaer-Zeitung. [*A. M.-Zeitung.*] *Semi-weekly.*
Darmstadt. Per year 24 *M.*

Archiv fuer die Artillerie-und Ingenieur Offiziere. [*Archiv.*] *Monthly.*
Koch Strasse, 68-78, *Berlin, S. W.* 12. *Per year* 12 *M.*

Beiheft zum Militaer-Wochenblatt. [*Beiheft.*]
Koch Strasse, 68, *S. W.*, *Berlin.*

Deutsche Heeres-Zeitung. [*Heeres-Zeit.*] *Semi-weekly.*
Wilhelmstrasse 15, *Berlin. Per year* $6.00.

Internationale Revue. [*Int. Revue.*] *Monthly.*
Blasewitzer Strasse 15, *Dresden. Per quarter* 6 *M.*

Jahrbuecher fuer die deutsche Armee und Marine. [*Jahrbuecher.*] *Monthly.*
Mohren Strasse, 19, *Berlin*, *W.* 8. *Per year* 32 *M.*

Kriegstechnische Zeitschrift. [*Kriegstech.*] *Ten numbers a year.*
Koch Strasse, 68-71, *Berlin. Per year* 10 *M.*

Kriegswaffen. [*Kriegswaffen.*] *Monthly.*
Rathenow, *Germany. Per year* $4.50.

Marine Rundschau. [*Mar. Rundschau.*] *Monthly.*
Koch Strasse, 68-70, *Berlin. Per year* 3 *M.*

Militaer-Wochenblatt. [*Wochenblatt.*] *Semi-weekly.*
Koch Strasse, 68, *Berlin*, *S. W.* 12. *Per Year* 20 *M.*

Militärische Rundschau. [*Mil. Rundschau.*] *Occasional.*
Zuckschwerdt & Co., *Leipzig. Per quarter* 4.75 *M.*

Stahl und Eisen. [*Stahl u. Eisen.*] *Fortnightly.*
Schadenplatz 14, *Düsseldorf. Per year* $5.00.

Umschau, Die. [*Umschau.*] *Weekly.*
Frankfort a. M. Per year 10 *M.*

AUSTRIA.

Mittheilungen ueber Gegenstaende des Artillerie und Genie-Wesens.
[*Mitth. Art. u. G.*] *Monthly.*
Wien, *VI*, *Getreidemarkt* 9. *Per year* 1 *Fl.* 50 *Kr.*

Mittheilungen aus dem Gebiete des Seewesens. [*Seewesens.*] *Monthly.*
Pola. Per year 14 *M.*

Organ der Militaer Wissenchaftlichen Vereine. [*Vereine.*]
Wien I, *Stauchgasse No.* 4. *Per year*, 8-14 *numbers*, 6 *Fl.*

Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines.
[*Z. Architekten Vereines.*] *Weekly.*
I. Eschenbachgasse, *No.* 9, *Wien. Per year* 10 *Fl.*

SWITZERLAND AND BELGIUM.

Allgemeine Schweizerische Militaer-Zeitung. [*A.S.M. Zeitung.*] *Weekly.*
Basel, *Switzerland. Per year*, 8 *Fr.*

La Belgique Militaire. [*Belgique M.*] *Weekly.*
Rue St. Georges 32, *Ixelles*, *Belgium. Per year* 12.50 *Fr.*

Monatschrift fuer Offiziere Aller Waffen. [*Monatschr.*] *Monthly.*
Frauenfeld, *Switzerland. Per year* 5 *Fr.*, *plus postage.*

Revue de l'Armée Belge. [*A. Belge.*] *Bi-monthly.*
22 *Rue des Guillemins*, *Liège*, *Belgium. Per year* 13 *Fr.*

Revue Militaire Suisse. [*R. M. Suisse.*] *Monthly.*
Escalier-du-Marché, *Lausanne*, *Switzerland. Per year* 10 *Fr.*

Schweizerische Zeitschrift fuer Artillerie und Genie. [*S. Zeitschrift.*] *Monthly.*
Frauenfeld, *Switzerland. Per year* 8 *Fr.* 20 *centimes.*

SPAIN, PORTUGAL AND SOUTH AMERICA.

Boletin del Centro Naval. [*Boletin.*] *Monthly.*
438 *Alsina, Buenos Aires, Argentina Republica. Per year* $11.00.

Circulo Naval,—Revista de Marina. [*Circulo Naval.*] *Monthly.*
Casilla num. 852, *Valparaiso, Chili.*

Memorial de Artilleria. [*M. de Art.*] *Monthly.*
Farmacia, num. 13, *Madrid, Spain. Per year, U. S.*, $3.40.

El Porvenir Militar. [*Porvenir.*] *Weekly.*
258 *Calle Montevideo, Buenos Aires, Argentina. Per year* 10 $ $\frac{m}{n}$.

La Prensa Militar. [*Prensa.*] *Weekly.*
Reconquista 1034, *Buenos Aires, Argentina.*

Revista Cientifico-Militar. [*Cientifico M.*] *Semi-monthly.*
5 *Calle de Cervantes, Barcelona, Spain. Per year* 32 *Fr.*

Revista da Commissao Technica Militar Consultiva. [*R. da Commissao.*] *Bi-monthly. Praça da Republica N.* 32, *Rio de Janeiro, Brazil.*

Revista de Engenheria Militar. [*Engenheria Mil.*] *Monthly.*
27 *Rua Nova do Almada, Lisbon, Portugal. Per year* 1 $ 800 *réis.*

Revista do Exercito e da Armada. [*Exercito.*] *Monthly.*
Largo de S. Domingos No. 11, *Lisbon, Portugal. Per year U. S* $6.00.

Revista General de Marina, [*R. G. de Marina.*] *Monthly.*
56 *Calle de Alcalá, Madrid, Spain. Price U. S.* $4.45.

Revista Maritima Brazileira. [*R.M. Brazil.*] *Bi-monthly.*
Rue do Conseheiro Saraiva n. 12, *Rio de Janeiro, Brazil. Per year* $1.575.

Revista Militar. [*R. Mil. Portugal.*] *Semi-monthly.*
262 *Rua da Princeza, Lisbon, Portugal. Per year,* $2.60.

Revista Militar. [*R. Mil. Chile.*] *Monthly.*
Santiago, Chili.

Revista Militar y Naval. [*R. Mil. y Nav.*] *Semi-Monthly.*
Calle Colonia, No. 379 *A. Montevideo, Uraguay.*

HOLLAND AND SCANDINAVIA.

Artillerie-Tidskrift. [*Art. Tids.*] *Bi-monthly.*
Stockholm, Sweden. Per year, U. S., $1.75.

De Militaert Gids. [*M. Gids.*] *Bi-monthly.*
De Erven F. Bohn, Haarlem, Holland. Per year, U. S., $2.00.

Militaert Tidsskrift. [*M. Tids.*] *Bi-monthly.*
Copenhagen, Denmark. Per year, U. S., $2.50.

Norsk Militeert Tidsskrift. [*N. M. Tids.*] *Monthly.*
Christiania, Norway. Per year, U. S., $2.50.

RUSSIA.

Artilleriiskii Journal. [*Art. Journal.*] *Monthly.*
Furschtatskaia Ulitza, St. Petersburg, Russia.

Razviedchik. [*Razv.*]
KoloKolwaia Ulitza, No. 14, *St. Petersburg, Russia.*

Russkii Invalide. [*Invalide.*]
Wadizdinskia Ulitza, No. 48, *St. Petersburg, Russia.*

ITALY.

Rivista di Artiglieria é Genio. [*R. Artig.*] *Monthly.*
Tipografia Voghera Enrico, Rome. Per year 30 *L.*

Rivista Marittima. [*R. Maritt.*] *Monthly.*
Rome. Per year 25 *L.*

UNITED STATES.

American Journal of Mathematics. [*Jour. Math.*]
John Hopkins University, Baltimore, Md.

American Machinist. [*Amer. Mach.*] *Weekly.*
256 *Broadway, New York City. Per year* $3.00.

American Manufacturer and Iron World. [*Man. and Iron World.*] *Weekly.*
59 *Ninth Street, Pittsburgh, Pa. Per year* $4.00.

Annual of the Office of Naval Intelligence. [*Naval Intelligence.*]
Washington, D. C.

Army and Navy Journal. [*A. and N. J.*] *Weekly.*
New York City. Per year $6.00.

Army and Navy Register. [*A. and N. R.*] *Weekly.*
Washington, D. C. Per year $3.00.

Bulletin of the American Mathematical Society. [*Bulletin Math. Soc.*]
University Heights, New York City. Ten numbers per year. $5.00 *per year.*

Cassier's Magazine. [*Cas. Mag.*] *Monthly.*
3, *West* 29*th Street, New York City. Per year* $3.00.

Digest of Physical Tests. [*Digest.*] *Quarterly.*
1424 *N.* 9*th Street, Philadelphia. Per year* $1.00.

Electrical Engineer. [*Elec. Eng.*] *Weekly.*
120 *Liberty Street, New York City. Per year* $3.00.

Electrical Engineering. [*Elec. Eng'ing.*] *Monthly.*
Monadnock Block, Chicago, Ill. Per year $1.00.

Electrical Review. [*Elec. Rev. N. Y.*] *Weekly.*
41 *Park Row, New York City. Per Year* $3.00.

The Engineer. [*Eng. N. Y.*] *Fortnightly.*
106-108 *Fulton Street, New York City. Per year* $2.50.

Engineering Magazine. [*Eng'ing. Mag.*] *Monthly.*
120-122 *Liberty Street, New York City. Per year* $3.00.

Engineering News and American Railroad Journal.
[*Eng'ing News.*] *Weekly.*
220 *Broadway, New York City. Per year* $5.00.

Engineering and Mining Journal. [*Eng. and Min. Jour.*] *Weekly.*
253 *Broadway, New York City. Per year* $5.00.

The Iron Age. [*Iron Age.*] *Weekly.*
232-238 *Williams Street, New York City. Per year* $4.50.

Journal of Electricity. [*Jour. Elec.*] *Monthly.*
421 *Market Street, San Francisco, Cal.*

Journal of the American Chemical Society. [*J. Chem. S.*] *Monthly.*
Easton, Pa. Per year $5.00.

Journal American Society of Naval Engineers. [*A.S.N. Egrs.*] *Quarterly.*
Navy Department, Washington, D. C.

Journal of the Association of Engineering Societies. [*Eng. Soc.*] *Monthly*
257 *South Fourth Street, Philadelphia. Per year* $3.00.

Journal of the Franklin Institute. [*Frank. Inst.*] *Monthly.*
Philadelphia, Pa., Per year $5.00.

Journal of the Military Service Institution. [*Jour. M. S. I.*] *Bi-monthly.*
Governor's Island, New York City. Per year $4.00.

Journal of the U.S. Cavalry Association. [*Jour. U. S. Cavalry*] *Quarterly.*
Fort Leavenworth, Kansas.

Journal of the Western Society of Engineers. [*W. Soc. Eng.*] *Bi-monthly.*
1737 *Monadnock Block, Chicago, Illinois. Per year* $2.00.

Marine Review. [*Mar. Rev.*] *Weekly.*
Cleveland, Ohio. Per year $2.00.

Military Information Division. [*Mil. Information Div.*] *Occasional.*
War Department, Washington, D. C.

Mines and Minerals. *Monthly.*
Scranton, Penn. Per year $2.00.

Notes on Naval Progress. [*Naval Intelligence.*] *Occasional.*
Navy Department, Washington, D. C.

Pennsylvania Magazine of History and Biography. [*Penn. Mag. of Hist.*] *Quarterly.*
13 *Locust Street, Philadelphia. Per year* $3.00.

The Photographic Times. [*Phot. Times.*] *Weekly.*
60 *and* 62 *E.* 11*th Street, New York City. Per year* $5.00.

Physical Review. [*Phys. Rev.*] *Ten numbers per year.*
Cornell University, Ithaca, New York. Per year $5.00.

Popular Science Monthly. [*Pop. Sc. Mo.*] *Monthly.*
72 *Fifth Avenue, New York City. Per year* $5.00.

Proceedings of the American Philosophical Society.
[*Proceedings of A. Phil. Soc.*]
104 *South Fifth Street, Philadelphia, Pa.*

Proceedings of the U. S. Naval Institute. [*Naval Inst.*] *Quarterly.*
Annapolis, Md. Per year $3.50.

Public Opinion. [*Pub. Opin.*] *Weekly.*
New York City. Per year $2.50.

Review of Reviews. *Monthly.*
13 *Astor Place, New York City. Per year* $2.50.

The Scientific American. [*Scien. Amer.*] *Weekly.*
361 *Broadway, New York City. Per year* $3.00.

Shooting and Fishing. *Weekly.*
293 *Broadway, New York City. Per year* $3.50.

Technology Quarterly. [*Tech. Quart.*] *Quarterly.*
Mass. Inst. of Tech., Boston, Mass. Per year, $3.00.

Transactions American Institute of Electrical Engineers.
[*Inst. Elec. Eng'rs.*] *Monthly.*
26 *Cortlandt Street, New York City. Per year* $5.00.

Transactions American Institute of Mining Engineers.
[*Trans. Inst. Min. Eng'rs.*]
P. O. Box 225, *New York City.*

Transactions of the American Society of Civil Engineers.
[*Trans. A. S. Civil Eng'rs*]
220 *West 57th Street, New York City.*

Transactions of the American Society of Mechanical Engineers.
[*Trans. A. S. Mech. Eng'rs.*]
12 *West 31st Street, New York City.*

Transactions of the Society of Naval Architects and Marine Engineers.
[*Naval Architects and Marine Eng'rs.*]
12 *West 31st Street, New York City.*

Western Electrician. [*West. Elec.*] *Weekly.*
510 *Marquette Building, Chicago, Illinois. Per year* $3.00.

Wilson's Photographic Magazine. [*Phot. Mag.*] *Monthly.*
853 *Broadway, New York City. Per year* $3.00.

ORGANIZATION AND ADMINISTRATION.

Report of the Secretary of War, U. S.—**A. and N. Jour.**, December 3.

The projected army, U. S.—**A. and N. Jour.**, December 17.

The two army bills, U. S.—**Pub. Opin.**, December 22.

General Miles' army bill.—**A. and N. Jour.**, December 10.

The Hull re-organization bill.—**A. and N. Jour.**, December 10.

Our army supply departments and the need of a general staff, U. S.—**Rev. of Rev.**, December.

Re-organization of the army, U. S.—**A. and N. Jour.**, December 31.

Increasing the army, U. S.—**A. and N. Jour.**, December 17.

The McClellan re-organization bill, U. S —**A. and N. Jour.**, December 17.

Re-organization of the State troops.—**Jour. M. S. I.**, November.

Necessity for a naval electrical engineer corps.—**Elec. Eng.**, December 29.

Torpedo militia.—**Elec. Eng.**, December 29.

Transportation of troops by sea.—**Jour. M. S. I.**, November.

Army transportation by sea.—**A. and N. Jour.**, December 24.

Recruiting for the army, England.—**A. and N. Gaz.**, November 19.

Economical army reform, England.—**Jour. R. U. S. I.**, November.

The colonial policy of Great Britian.—**Wochenblatt**, December 14.

The defense of Canada.—**Can. Mil. Gaz.**, December 6.

A militia system, Canada.—**Can. Mil. Gaz.**, December 6.

The pressing need of the Indian army.—**United Serv. Mag.**, December.

The creation and maintenance of a reserve of officers for the Indian army.—**Jour. R. U. S. I.**, October.

Australian defense.—**U. S. Gaz.**, December 17.

The necessity for and practicability of a federal Australian army.—**Jour. R. U. S. I.**, November.

England's naval supremacy.—**R. M. Brazil**, August.

The British fleet in commission (1897-1898).—**United Serv. Mag.**, December.

Naval vs. military power.—**U. S. Gaz.**, December 3.

The Board of the Admiralty.—**United Serv. Mag.**, December.

Naval engineers.—**Eng'ing.**, December 2.

The military state of England and France compared.—**A. S. M. Zeit.**, November 12.

The French active army.—**Jour. M. S. I.**, November.

Project for the naval budget, 1899, France.—**Yacht**, December 3.

The French naval estimates.—**Eng.**, December 2.

The French navy.—**Eng.**, November 25.

Military projects in Germany.—**Cercle**, November 26.

Re-organization of the Prussian war ministry.—**A. S. M. Zeit.**, November 26.

Pertinent questions on the organization of the German Imperial army.—**Heeres-Zeit.**, December 10.

New German military organization.—**Cercle**, December 10.

Re-organization of the German field artillery (divisional or corps artillery).—**R. Artillerie**, November.

The organization of the German field artillery.—**Int. Revue**, November.

Modifications in the organization of the German army.—**Etranger**, November.

The Russian army.—**United Serv. Mag.**, August, September, November.

The State defenses of Russia.—**Jour. R. U. S. I.**, December.

An abstract of the field medical systems of the German, French and Austrian armies.—**Jour, U. S. I. India**, October.

The Chinese army.—**United Serv. Mag.**, November, December.

The Japanese navy and Japan's naval program.—**Yacht**, November 12.

The Italian Royal Carbineers.—**Cercle**, December 17.

Organization of our colonial forces, Portugal.—**R. Mil. Portugal**, December 15.

The neutrality and defense of Denmark.—**Int. Revue**, December.

The ministry of marine, Brazil.—**R. M. Brazil**, November.

The now code of military proceedure, Belgium.—**A. Belge**, September-October.

The law of promotion in the Italian army.—**R. Maritime**, October.

Naval organization, Uraguay.—**R. Mil. y Naval**, November 15.

The two-year service in the German Infantry.—**Cercle**, November 12, 19; December 17.

Strength of artillery in proportion to the other arms.—**Heeres-Zeit.**, November 12-30; December 3-17.

Infantry equipment and supplies.—**R. Inf.**, November.

Military telegraph organization.—**Heeres-Zeit.**, December 14.

Mounted infantry in South Algeria and the Sahara.—**R. Inf.**, December.

The volunteer in war.—**United Serv. Mag.**, December.

Coast defense organization.—**Heeres-Zeit.**, December 7.

The navy in coast defense.—**Jour. M. S. I.**, November.

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